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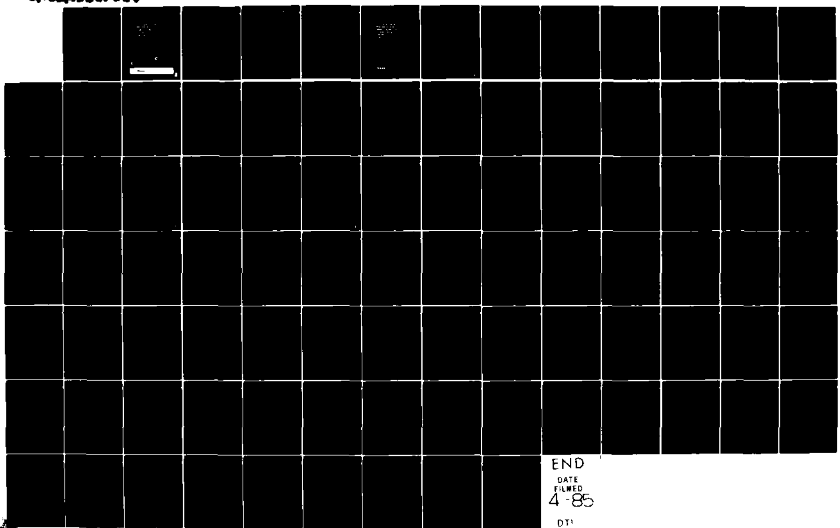

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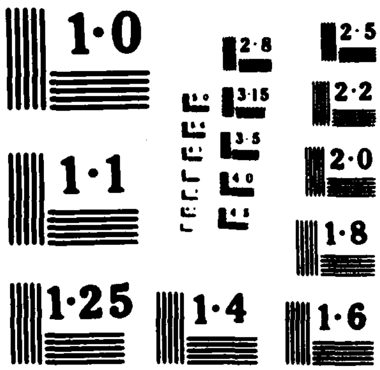
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AD-A150 821

# Setting Enlistment Standards and Matching Recruits to Jobs Using Job Performance Criteria


Richard L. Fernandez
With Jeffrey B. Garfinkle




Rand

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Every year the military services are faced with the tremendous tasks of choosing 300,000 new recruits from among the larger number who are willing to serve, and of deciding in which specialty each of the 300,000 should be trained. This report describes a study largely concerned with determining whether there is any objective basis for enlistment standards and for matching recruits to jobs. It develops a cost/performance tradeoff model that appears to be a useful tool for setting job standards and for prescribing appropriate service-wide standards, but finds that three questions must be answered before the model can be used objectively. A key element of the model is the "qualified man-month," a single performance measure that combines attrition and job performance information. A related Rand report, [Recruit Aptitudes and Army Job Performance: Setting Enlistment Standards for Infantrymen], R-2874, provides useful background to this report. Bibliog.

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# Setting Enlistment Standards and Matching Recruits to Jobs Using Job Performance Criteria

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With Jeffrey B. Garfinkle

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Prepared for the
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# PREFACE

In 1980 the Department of Defense announced the discovery that for some years the military enlistment-eligibility test had been seriously misscored. As a result of the discovery, attention was focused in both the Congress and the military services on the relationship between measured aptitudes and job performance. Each of the military services is engaged in a major effort to improve its measurement of performance. This report illustrates the usefulness of information on military job performance in setting standards for enlistment and matching recruits to military specialties.

This is the final report of a two-year study, performed within Rand's Defense Manpower Research Center and sponsored by the Office of the Assistant Secretary of Defense (Manpower, Installations, and Logistics). It builds upon results previously reported in David J. Armor, Richard Fernandez, Kathy Bers, and Donna Schwarzbach, *Recruit Aptitudes and Army Job Performance: Setting Enlistment Standards for Infantrymen*, R-2874-MRAL, September 1982. An understanding of the material in the earlier report would be useful as background in reading the current work.

# SUMMARY

Every year the military services face the tremendous tasks of choosing some 300,000 new recruits from among the larger number who are willing to serve, and of deciding in which specialty each of the 300,000 should be trained. Because most of these recruits have no prior military experience and little or no civilian work experience, virtually the only information the services have to guide their choices is the educational attainment of each applicant and whatever additional information can be obtained through tests.

Between January 1976 and September 1980, the services' tasks were made more difficult by an incorrectly scored Armed Services Vocational Aptitude Battery (ASVAB), the principal military selection and classification tool. During that period, only 5 percent of active duty enlistees had been reported to have scored between the 10th and 30th percentiles on the Armed Forces Qualification Test (AFQT), a measure of general aptitudes derived from the ASVAB. After the scoring error was discovered, it became apparent that the correct percentage was 30. Among Army enlistees, 9 percent had been reported in this range (called "Category IV"), but the true number was 46 percent. Scores on aptitude area "composites"—also derived from the ASVAB and used to determine eligibility for assignment to specific military specialties—were equally affected.

A new, correctly calibrated ASVAB was introduced in October 1980, but the discovery of the miscalibration had raised several important questions for military manpower policymakers. Principal among these was whether there is any objective basis for deciding who should be allowed to enlist, and in which specialty each recruit should be placed. This study has attempted to answer this and related questions by relating available measures of job performance to characteristics of the recruit that are observable at the enlistment point.

We examine four Army jobs, chosen to represent the range of skills required in the Army. We used two performance measures: (1) the tendency of the enlistee to complete the initial tour, which is principally related to whether he or she completed high school; and (2) performance on the Skill Qualification Test (SQT) for his or her assigned specialty, which is strongly related to the enlistee's ASVAB test scores. The two measures give sometimes conflicting indications of what sorts of recruits should be sought, but they can be combined in a single measure: qualified man-months (QMM). A QMM is (roughly) a working month contributed by an enlistee who meets minimum acceptable

job performance standards as measured by the SQT. In general, enlistees who did not graduate from high school but who scored high on the ASVAB tests (above the 64th percentile, for example) produce more qualified man-months than do high school graduates with low scores (below the 31st percentile). Thus, unless members of the latter group are much less costly to recruit, the Army's policy of emphasizing high school diplomas over high test scores appears to be misplaced.

The Army, like the other services, determines who will be permitted to enlist through the *enlistment standards* it sets. Both formal and informal standards are used. Formal standards are minimum acceptable test scores, both for enlistment and for assignment to specific jobs; informal standards are implicit in the incentives given to Army recruiters to bring in certain types of recruits, and in the procedures used by Army guidance counselors to match recruits to jobs. Together these standards determine, along with the amount of resources devoted to recruiting and the general willingness of young people to enlist, the quality mix among entering recruits, both for the Army as whole and for individual Army specialties.

A viable tool for determining optimal standards for individual jobs and, by extension, for prescribing an optimal quality mix among all Army enlistees, is the *cost/performance tradeoff model* developed in this study. We use the model to find that set of standards for our four jobs, each of which is taken to represent a portion of the total force, that minimizes the sum of recruiting, training, and force maintenance costs over the course of a typical three-year initial tour. Each job is constrained to receive a specified level of QMM.

Raising the standard for a job increases its requirement for costly-to-recruit "high-quality" enlistees (high school graduates who score above the 50th percentile on the AFQT), but allows the specified QMM level to be obtained with fewer total enlistees. The precise way in which a higher standard changes the characteristics of recruits entering a particular job is given in the model by the *proportionality assumption*, which states that any given level of the standard will bring in recruits with the same distribution of characteristics as that of enlistees who scored above that level in the past. Thus, the optimal standards the model generates depend upon what "past" is used for determining recruit characteristics. We used two rather different periods: FY77-FY80, during which the misnormed ASVAB was in use; and FY81, a period of much easier recruiting, higher standards, and a correctly normed test.

The more favorable recruiting environment of FY81 brought the Army greater numbers of QMM in all four jobs, but the standards that would yield these numbers at least cost were similar to those generated

by the model for the earlier period. In general, the optimal standards generated by the model are slightly higher than those adopted by the Army after the discovery of the misnormed test.

Because a reduction in force size may not be acceptable even if it can be shown to have no effect on aggregate performance levels, we also explored optimal standards for higher levels of QMM. The higher levels were chosen so as to yield no reduction in force size when cost-minimizing standards were applied. In contrast to the cost savings available with a smaller force size, achieving the higher performance levels would add $220 million to $270 million Army-wide (5 to 6 percent) to the first-term variable cost of a one-year enlistment cohort.

An alternative way of improving performance, without increasing costs, is to improve the matching of recruits to jobs. A plausible objective is to maximize job performance, but maximizing performance in one specialty will necessarily require sacrificing performance in others. Thus, the optimality of matches must be judged against an objective function that aggregates performance across jobs. We generated optimal matches under two aggregation schemes: In one, the QMM of our four jobs were simply added together; in the other, weights were applied so as to yield higher QMM totals in each job than the Army obtained from the same recruits. As with the enlistment standards model, we considered both a set of recruits with the characteristics of those who entered our four jobs during FY77-FY80, and another set with the characteristics of FY81 enlistees.

Using the performance data to generate optimal matches yielded only small improvements in performance—5 to 6 percent—relative to what the Army achieved, regardless of which aggregation scheme was used in the generation or evaluation of the matches. Further, there is no evidence that the Army's matches were any worse, measured relative to our optimal matches, during the period of the miscalibrated ASVAB than they were after the new test was introduced. The potential improvements are not large enough to imply that the Army could have done better than it did in either period, but similar gains achieved through higher standards could cost on the order of $200 million annually. Thus, an important question for further research is how binding are the constraints faced by the Army in having to deal with recruits' preferences and day-to-day requirements for filling training slots, constraints that we ignored. Whatever the results of that research, it is clear that large changes in the numbers of QMM in individual jobs can be obtained, depending on the relative importance placed on performance in the various jobs.

This study illustrates the usefulness of the cost/performance trade-off model for the setting of enlistment standards, and of job

performance measures for matching recruits to military specialties. It also shows, however, that three questions must be answered before the standard-setting and job-matching processes can be made truly objective. Both processes require an answer to the question: *What is the relative importance of performance in different jobs?* Even if this answer must be someone's subjective evaluation, having it available would at least allow the two processes to go on without their having to be imbedded in a total defense resource allocation framework. The other two questions arise in the setting of enlistment standards: *Can a smaller force of more-capable enlistees really replace a larger force of less-capable*; and given an evaluation of the relative importance of performance in different jobs, *How much is better performance worth paying for?* Answers to these three questions should be sought in parallel with efforts to improve the measurement of job performance.

# ACKNOWLEDGMENTS

Many people gave generously of their help during the course of this study. W. S. Sellman, Director, Accession Policy, OASD(MI&L), helped guide the research and offered useful comments on an earlier draft of this report. Robert Brandewie and Jane Crotzer of the Defense Manpower Data Center provided most of our data and aided in its interpretation. Rand colleague Kathy Bers did much of the preliminary data analysis and worked on the computer code for the cost/performance tradeoff model. Other Rand colleagues provided insightful comments on earlier drafts: Grace Carter, Glenn Gotz, and Robert Heavner. A very careful review came from Michael G. Rumsey, Chief, Performance Measurement Team, U.S. Army Research Institute for the Behavioral and Social Sciences.

We owe special thanks to David J. Armor, who directed this study until his departure from Rand in 1982, and under whose guidance the cost/performance tradeoff model was developed.

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# I. INTRODUCTION

Every year, the active military services lose one-sixth of their enlisted force as senior personnel retire and junior personnel leave either because they decide not to reenlist or because they are separated for poor performance or failure to adapt to military life. To replace them, the services repeatedly face the tremendous task of selecting about 300,000 recruits from among the larger number of applicants, and deciding in which specialty each of them should be trained. Most of these recruits have no prior military experience and little or no civilian work experience. Thus, virtually the only information the services have to go on is educational attainment and the results of tests administered to the applicants.

The Armed Services Vocational Aptitude Battery (ASVAB) is the principal selection and classification tool. It consists of a number of subtests, four of which are combined to yield a measure of general aptitude and trainability—the Armed Forces Qualification Test (AFQT). In conjunction with educational attainment, the AFQT score is used to determine enlistment eligibility. Scores on other subtest composites ("aptitude area" scores) are used to qualify recruits for specific specialties.

In February and March 1980, the Assistant Secretary of Defense for Manpower, Reserve Affairs, and Logistics informed the House and Senate Committees on Armed Services that there was a problem with the norming of the ASVAB, and that as a result the services might have been accepting a higher proportion of low-scoring enlistees than had previously been believed. In a subsequent report to the House Committee, the Office of the Assistant Secretary presented the results of a just-completed study assessing the extent of the misscoring.[1] In fiscal year 1979, only 5 percent of total nonprior-service military enlisted accessions had been reported to have scored between the 10th and the 30th percentiles (compared with the World War II mobilization population) on the AFQT; the correct percentage was 30. Among Army enlistees, only 9 percent had been reported in this range, but the true number was 46 percent. Scores on the aptitude area "composites" were equally miscalibrated. As a result, of the enlistees who entered the infantry specialty in fiscal years 1977 through 1980, for example, 42

[1]Office of the Assistant Secretary of Defense (Manpower, Reserve Affairs, and Logistics)—OASD(MRA&L)—1980(a). The report also describes the series of studies that led to the decision of the Department of Defense to examine the norming issue.

percent scored below the intended minimum score for that job on the Combat Arms composite.

A new, correctly calibrated ASVAB was introduced in October 1980, but the discovery of the miscalibration had raised several important questions for military manpower policymakers, among them:

- Can low-scoring recruits perform most military jobs, or did their influx seriously degrade military job performance?
- Where should minimum enlistment standards be set on the correctly scored AFQT?
- What should be done with the standards for individual jobs? Should they be left at the low levels where they had been because of the miscalibrated ASVAB, or raised back to their old nominal levels, or set somewhere in between, or pushed even higher?
- How had the low job standards affected the abilities of the services to place recruits into the jobs they were best suited for?
- Is there any objective basis for setting standards for enlistment, either into a service as a whole or into specific jobs, or for determining the "right" job for each recruit?

Even as miscalibration raised these questions, however, it offered a means for answering at least some of them. Because so many low-scoring recruits had been admitted, it was possible to examine their success in the military.[2] Measuring success is a major problem, but a usable tool for the purpose is the Army's unique Skill Qualification Test (SQT). The SQT is actually a set of tests, one for each Army specialty and skill level, that measure the soldier's ability to perform specific tasks required on the job. Although not intended to assess individual job proficiency, the SQT appears to be capable of serving that purpose. Until current efforts by the services to improve their measurement of job performance bear fruit,[3] the SQT will be the best measure available.

The study described in this report attempted to answer all of the questions above, but particularly the last. At this stage in the development of performance measures, and of the theoretical tools for analyzing them, firm answers to the first three questions are not yet possible. In addition, all of the analyses reported here are limited to first-term costs and benefits; possible effects on the numbers and types of enlistees in the career force are ignored.

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[2]*Two early studies were reported in* OASD(MRA&L), 1980(b).

[3]See OASD(MRA&L), 1981.

In answer to the last question—Are there objective bases for setting enlistment standards and for matching individuals to jobs?—our answer is a qualified yes. We have developed a method, imbedded in a cost/performance tradeoff model, for examining optimal enlistment standards, and we have explored optimal recruit assignments by using a performance measure developed for that model. The model results suggest that the enlistment standards currently used by the Army—for determining both basic enlistment eligibility and acceptability for specific jobs—may be somewhat too low. The standards in use during the period of the miscalibrated test were also too low, even given the less favorable recruiting environment of the last years of that period. The Army's matching of recruits to jobs appears not to have been as good as is theoretically possible, but the potential improvement is so small that the failure to realize it may simply have been due to the day-to-day constraints, and the preferences of individual recruits, that the Army must face but that we did not consider.

The affirmative answer is qualified for two main reasons. First, the best available job performance measure—the Army's Skill Qualification Test—is not well accepted as adequate. It remains to be seen whether the relationships that hold between SQT success and such recruit characteristics as ASVAB test scores and education will persist as strongly, or at all, for the improved measures being developed. Second, and probably more important, the objective functions used in this study—what those elements are that are maximized or minimized in determining "optimal" standards or job matches—are not entirely satisfactory. Setting standards to minimize costs requires accepting the assertion that a smaller force of more-capable individuals can literally replace a larger force of less-capable. Maximizing total performance, a logical objective in matching individuals to jobs, is an ambiguous concept, requiring the adding together of performance measures in diverse jobs.

The problem of choosing objective functions cannot be solved in the context of setting standards or making job assignments alone. It also requires answering questions that go far beyond the scope of this study, such as:

- Are performance-adjusted substitutions among different categories of recruits really possible, and can the services be structured to take advantage of them?
- What is the relative importance of performance in different specialties?
- How much is better performance worth paying for?

This study demonstrates, implicitly, the importance of these questions, and shows the need for pursuing answers to them in parallel with the efforts to improve performance measurement.

# II. MEASURING PERFORMANCE

It would be possible to forget about standards, accept all volunteers, and assign them randomly to jobs. To improve on such a policy, we must possess some measure of individual performance, and some way to predict success on that measure using only characteristics of the individual that can be observed at the enlistment point. In the past, two performance measures have been used: (1) first-term attrition (leaving before the end of the initial active-duty obligation) and (2) training school success. Based on the well-established relationship between graduation from high school and completion of an enlistment tour, the services have emphasized the recruitment of high school diploma graduates (HSDGs). Standards for acceptance into individual jobs have been based on observed relationships between training school grades and scores on ASVAB aptitude area composites.

The traditional performance measures, and the way in which they have been used, suffer from three problems. First, changes in training methods have weakened the relationship between an individual's measured aptitude and the probability that he or she will complete training. Most recruits who stay in the Army now complete training, but—as will be seen below—this does not mean that low- and high-aptitude recruits are equally capable of performing their jobs. Second, even apart from the first problem, high scores in training school may not predict ability to perform the job. The individual characteristics that determine ability to perform well in a classroom setting may differ sharply from those determining success under the different pressures, and with the specific set of required tasks, in a particular job setting. Finally, in applying the traditional performance measures to the selection of recruits for military service and their assignment to jobs, the services have given little consideration to the possible trade-offs between success under one measure and success under the other. Thus, because no information on job performance has been available, Army recruiting policies in recent years have favored low-aptitude HSDGs over high-aptitude nongraduates, even though the nongraduates might outperform the HSDGs on any job.

This section examines the relationship between individual entry characteristics and success on two performance measures, one traditional—attrition—and one new—the Army's Skill Qualification Test (SQT). Data are presented for the four Army jobs that were used in this study, chosen to represent the variety of skills required in the

Army. The two performance measures are combined into a single measure—qualified man-months (QMM)—that is used in the remainder of this study.

## FOUR ARMY JOBS

The four jobs and their military occupational specialty (MOS) classifications are: Infantryman (11B), Multichannel Communications Equipment Operator (31M), Tactical Wire Operations Specialist (36K), and Medical Specialist (91B). Appendix A gives official descriptions of the job tasks performed by junior enlisted members in each specialty. For simplicity, we use the following descriptive—but not official—short titles in the remainder of this report: 11B—Infantry; 31M—Radio; 36K—Wireman; 91B—Medical.

Table 2.1 compares the four jobs with other Army jobs in terms of the entry characteristics of nonprior-service recruits who signed enlistment contracts for those jobs during fiscal year 1981. The listed jobs include all those with more than 1000 contracts, and together account for 60 percent of the 130,000 Army total. AFQT scores in Table 2.1 are percentiles relative to the World War II mobilization population, which matches today's general youth population fairly closely in terms of raw scores on this test.[1] Although the aptitude area composites are not scored in percentile terms, average scores on the various composites are approximately the same, so jobs with high minimum scores can be considered difficult to qualify for, and those with low scores easy to qualify for.

Our four jobs spanned a wide range in the quality of enlistees and minimum scores required. Enlistees in 36K (Wireman) had a mean AFQT score of only 32.9—among the lowest in all jobs—but 83 percent were high school graduates. At the other end of the AFQT scale, 91B (Medical) showed a mean score of 55.8, and more than 90 percent high school graduates. 11B (Infantry) and 31M (Radio) were near the average in both AFQT score and HSDG percentage. Minimum aptitude area scores ranged from 85 for 11B (the lowest minimum for any job) to 95 for 31M and 91B. In terms of numbers of enlistees, Table 2.1 is somewhat deceiving. The MOS 11X is a special designator, recently introduced, for enlistees who are to be assigned one of several Infantry MOSs—mostly 11B—upon completion of training. 11B ultimately receives the largest number of enlistees of all jobs: three to four times as many as the other three jobs examined in this study.

[1]In 1980, the ASVAB was given to a nationwide representative sample of young people. See OASD(MRA&L), 1982.

# Table 2.1

## CHARACTERISTICS OF FY81 ENLISTEES IN LARGE ARMY JOBS

| | MOS | Mean AFQT | HSDG (%)[a] | Cum % AFQT[b] | Cum % HSDG[c] | Contracts[d] (%) | Test[e] | Min Score[f] | MOS Title |
|---|---|---|---|---|---|---|---|---|---|
| | 76V | 29.1 | 90.2 | 2.8 | 81.6 | 0.92 | CL | 90 | Materiel Storage & Handling Spec |
| | 76P | 29.6 | 94.3 | 4.1 | 87.4 | 1.33 | CL | 90 | Materiel Control & Accounting Spec |
| >> | 36K | 32.9 | 83.1 | 6.7 | 71.3 | 1.90 | EL | 90 | Tactical Wire Operations Spec |
| | 76C | 33.5 | 79.5 | 9.1 | 66.2 | 2.36 | CL | 95 | Equipment Records & Parts Spec |
| | 36C | 36.0 | 75.0 | 12.6 | 41.9 | 0.83 | EL | 90 | Wire Systems Installer Operator |
| | 63B | 39.0 | 76.2 | 18.1 | 44.7 | 3.14 | MM | 85 | Light Wheel Veh /Power Gen Mechanic |
| | 13B | 39.1 | 78.9 | 22.7 | 62.7 | 3.96 | FA | 85 | Cannon Crewman |
| | 76Y | 41.0 | 74.5 | 29.0 | 40.8 | 3.10 | CL | 95 | Unit Supply Specialist |
| | 75D | 41.1 | 79.5 | 29.8 | 63.8 | 0.86 | CL | 95 | Personnel Records Specialist |
| | 94B | 41.1 | 65.1 | 32.5 | 21.8 | 2.66 | OF | 85 | Food Service Specialist |
| | 64C | 41.5 | 70.2 | 36.5 | 25.1 | 4.02 | OF | 85 | Motor Transport Operator |
| | 75B | 43.2 | 79.9 | 39.0 | 67.3 | 1.07 | CL | 95 | Personnel Administration Spec |
| | 12B | 44.4 | 76.8 | 42.7 | 51.7 | 2.84 | CO | 85 | Combat Engineer |
| | 71L | 45.2 | 94.4 | 47.2 | 91.2 | 1.32 | CL | 95 | Administrative Specialist |
| | 19A | 45.4 | 68.0 | 49.6 | 18.9 | 2.45 | CO | 85 | Armor Specialist |
| | 19D | 45.5 | 76.8 | 51.1 | 53.5 | 1.40 | CO | 85 | Cavalry Scout |
| | 31V | 47.6 | 57.3 | 53.6 | 5.4 | 0.79 | EL | 95 | Tactical Comm Systems Op /Mech |
| | 11X | 47.6 | 71.4 | 60.9 | 33.0 | 7.33 | CO | 85 | Infantry |
| | 63T | 48.1 | 44.2 | 62.5 | 1.6 | 0.92 | MM | 100 | ITV/IFV/CFV System Mechanic |
| >> | 11B | 48.7 | 74.1 | 65.6 | 37.4 | 2.90 | CO | 85 | Infantryman |
| >> | 31M | 50.7 | 67.3 | 68.2 | 16.0 | 1.93 | EL | 95 | Multichannel Comm Equipment Oper |
| | 05B | 52.2 | 78.6 | 71.6 | 58.7 | 1.29 | SC | 90 | Radio Operator |
| | 13F | 54.7 | 69.0 | 74.7 | 21.0 | 0.86 | FA | 100 | Fire Support Specialist |
| | 91C | 55.6 | 90.2 | 76.5 | 84.0 | 1.41 | ST | 95 | Patient Care Specialist |
| >> | 91B | 55.8 | 77.8 | 78.4 | 56.0 | 1.97 | ST | 95 | Medical Specialist |
| | 05C | 56.1 | 75.1 | 81.5 | 44.7 | 2.69 | SC | 95 | Radio Teletype Operator |
| | 95B | 57.5 | 86.8 | 87.4 | 79.4 | 4.67 | ST | 100 | Military Police |

[a]High school seniors who were expected to complete high school before beginning active duty were considered diploma graduates

[b]Percent of enlistees in jobs with equal or lower mean AFQT scores

[c]Percent of enlistees in jobs with equal or lower HSDG percentages

[d]Enlistees in the job as a percentage of total

[e]Aptitude area composite used for qualification into the job

[f]Minimum score on the specified aptitude for composite for enlistment into the job

Table 2.2 gives a breakdown by AFQT category and high school status of enlistees in the four jobs during two periods: FY77 through FY80, and FY81. Data for the earlier period represent accessions: individuals who began active duty during the period. The percentile scores corresponding to the AFQT categories are: I: 93-100; II: 65-92; IIIA: 50-64; IIIB: 31-49; and IV: 10-30. Category IV is sometimes broken down further: IVA: 21-30; IVB: 16-20; and IVC: 10-15. Individuals in Category V (1-9 percentiles) are excluded from peacetime military service.

Three points are particularly worth noting in Table 2.2. First, during the earlier period, when incorrect test norms were applied, high

Table 2.2

ENLISTEES IN FOUR JOBS BY AFQT CATEGORY AND HIGH SCHOOL STATUS: FY77-80 AND FY81 (PERCENT)

| | AFQT Category | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MOS | I-II | IIIA | IIIB | IV | Total | I-II | IIIA | IIIB | IV | Total |
| | FY77-FY80[a] | | | | | FY81[b] | | | | |
| *11B* | | | | | | | | | | |
| HS | 11.4 | 6.1 | 9.0 | 23.0 | 49.5 | 24.8 | 12.1 | 16.2 | 16.9 | 70.0 |
| NHS | 4.1 | 5.4 | 12.4 | 28.6 | 50.5 | 5.5 | 6.2 | 16.4 | 1.8 | 30.0 |
| Total | 15.5 | 11.5 | 21.4 | 51.6 | | 30.3 | 18.3 | 32.6 | 18.7 | |
| *31M* | | | | | | | | | | |
| HS | 6.0 | 5.9 | 10.6 | 36.8 | 59.3 | 19.8 | 15.1 | 20.2 | 11.4 | 66.5 |
| NHS | 2.4 | 3.4 | 8.7 | 26.2 | 49.7 | 7.8 | 8.4 | 16.2 | 1.0 | 33.4 |
| Total | 8.4 | 9.3 | 19.3 | 63.0 | | 27.6 | 23.5 | 36.4 | 12.4 | |
| *36K* | | | | | | | | | | |
| HS | 4.1 | 3.9 | 8.3 | 44.7 | 61.0 | 4.9 | 6.5 | 15.3 | 52.3 | 79.0 |
| NHS | 2.0 | 2.9 | 8.9 | 25.3 | 39.1 | 1.5 | 2.4 | 14.0 | 3.1 | 21.0 |
| Total | 6.1 | 6.8 | 17.2 | 70.0 | | 6.4 | 8.9 | 29.3 | 55.4 | |
| *91B* | | | | | | | | | | |
| HS | 16.4 | 11.0 | 15.9 | 22.8 | 66.1 | 29.6 | 17.5 | 20.6 | 11.8 | 79.5 |
| NHS | 5.5 | 5.6 | 10.6 | 12.3 | 34.0 | 5.7 | 5.9 | 8.4 | 0.5 | 20.5 |
| Total | 21.9 | 16.6 | 26.5 | 35.1 | | 35.3 | 23.4 | 29.0 | 12.3 | |

[a]Percentages given are for *correctly* normed AFQT scores.

[b]High school graduate percentages may not agree exactly with those in Table 2.1, where the numbers are based on a sample of enlistees.

proportions of enlistees in all four jobs were in Category IV. 36K was the worst in this respect, with 70 percent Category IV and only 13 percent at or above the 50th percentile (I-IIIA). Even 91B had more than 62 percent below the 50th percentile, and 35 percent in Category IV. Second, in the more favorable recruiting environment of FY81, all four jobs received much greater percentages of high school graduates than in the earlier period. This can be traced to the virtual elimination of nongraduate enlistees in Category IV during FY81. Official Army policy did not permit enlistments from this group in either period, but large numbers were allowed to enlist in the earlier period because they were incorrectly classified in Category IIIB. Third, despite the similarity of the jobs in terms of the changes that took place between the two periods, these four jobs exhibit considerable diversity in the distribution of their enlistees among the eight HS/AFQT groups.

## ATTRITION

Remaining in the service is an important component of an enlistee's job performance. As will be seen below (Sec. IV), training costs, including the enlistee's pay during this nonproductive period, constitute a large portion of the total cost of maintaining the individual through the first tour. Thus, an enlistee who is barely competent at his or her job, but completes the initial tour, might be worth more to the Army than one who performs perfectly for two or three months and leaves.

Figure 2.1 shows retention rates over the typical three-year tour for each of our four Army jobs, broken down by high school status and based on data for the FY77 accession cohort.[2] The two- and five-month points correspond approximately to the end of basic and advanced training, respectively. After the five-month point, retention rates are plotted at six-month intervals.

Retention patterns for the four jobs are similar. Much of the attrition occurs during the first five months, particularly during basic training. High school graduates are consistently more likely to stay than are nongraduates, as other studies have found (e.g., Buddin, 1981). A finer breakdown of education shows holders of GED certificates to be less likely to stay than even nongraduates, although the number of

[2]Identification of the enlistee's job is based on the commitment MOS, which appears on his or her training record. No attempt was made to control for subsequent job changes. Appendix C shows that such changes were most common for 11B and 91B. In the models presented in Secs. IV and V, we ignore job changes and thus implicitly assume that movements out of each job are matched by movements in, and that those moving in match those moving out in both entry characteristics and attrition behavior.

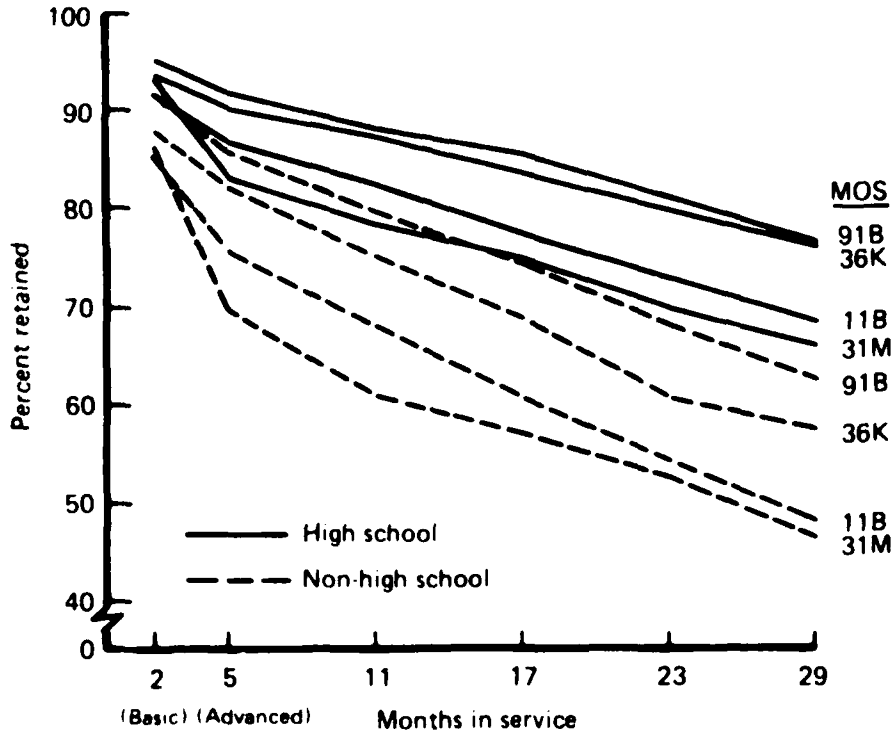


Fig. 2.1—Retention Rates for Four Army Jobs, by High School Status (FY77 Accessions)

such enlistees in the sample is too small to permit a firm conclusion. It appears that attrition may be related to the job, or to unmeasured characteristics of people who enter certain jobs; cumulative retention rates at the 29-month point are about ten percentage points higher for 36K (Wireman) and 91B (Medical) than for the other two jobs. This result suggests that controls for specific jobs, or job characteristics, should be introduced in analyses of attrition behavior.

Other entry characteristics of the enlistees in these jobs had little relationship with their attrition behavior.[3] The largest effect was a tendency for blacks to leave less frequently than whites, particularly during training (retention rates about 5 to 10 percentage points higher at the end of five months, with the difference increasing slightly through the 29th month). Higher-aptitude enlistees—as measured by either AFQT or the aptitude area composite used to qualify enlistees for the particular job—exhibited essentially the same attrition behavior as those with lower test scores. This held even for the advanced training

[3]All of the comparisons reported here are based on cross-tabulations in which educational attainment (HS vs. NHS) is controlled.

period, when we might expect to see low-scoring recruits leaving because they were unable to complete the course.[4] Finally, in the two jobs in which there were enough females to permit inference, females had lower retention rates than males.

The retention data for these four jobs seem to support the Army's policy of emphasizing the recruitment of high school graduates. Regardless of their test scores, nongraduates are much less likely than graduates to complete 29 months: 30 percent less likely in 11B, 29 percent in 31M, 24 percent in 36K, and 18 percent in 91B. It remains to be seen, however, whether these differences in retention are the dominant factor determining the relative cost-effectiveness of various groups of enlistees when ability to perform the job is considered as well.

## JOB PERFORMANCE

The principal reason that training success has been used to validate enlistment standards is that, until recently, no measure of post-training performance has been available. With the introduction of the Army's Skill Qualification Test in the late 1970s, this circumstance has changed. The SQT was designed to assess training needs, but there is nothing in its design to prevent its use for measuring performance. It is an objective test, developed and revised by special staff at each training school, that evaluates proficiency in representative tasks deemed essential to carrying out specific job responsibilities. The passing score set for each job's test is intended to define the minimum level of acceptable performance.

The typical SQT consists of three components: a Job-Site Component (JSC), a Hands-On Component (HOC), and a Skill Component (SC).[5] The JSC is administered by the enlistee's direct supervisor, who observes him or her performing specific tasks in an actual job setting. Because scores for this component are consistently high, it contributes little to the SQT assessment of competence. In the HOC, the enlistee performs job tasks under standardized conditions, with trained scorers observing him or her in a formal test site. The tasks to be tested are

[4]This may simply mean that recruits who cannot complete training in their commitment MOSs are transferred to other specialties, rather than being separated (or being allowed to separate). We did observe more shifting out of MOS 91B, the one of our four jobs with the highest standard and presumably the most difficult training, than out of the other specialties (see App. C).

[5]A more complete description and evaluation of the SQT appears in Wagner et al. (1982). Regulation 351-2 of the U.S. Army Training and Doctrine Command (TRADOC) governs test development.

announced in advance, so that practice is possible,[6] but people with high AFQT scores tend nonetheless to outperform those with low scores. Finally, the SC is a pencil-and-paper, multiple-choice test. Scores on this component contribute most to the overall correlation between SQT passing and entry test scores, but they also are correlated significantly with HOC scores. Every first-term enlistee with at least one year of service and three months on the job must take the SQT for his or her primary MOS annually.

The General Accounting Office (1982) strongly criticized the SQT, principally because of the small number of tasks tested in the HOC and the advance announcement of those tasks. Although these criticisms may be valid, they do not necessarily mean that the relationships that are found between entry characteristics and performance on the SQT would not hold for a more carefully designed test of individual job performance. Indeed, Armor et al. (1982) have shown that the relationship between AFQT score and performance on the Infantryman SQT is very similar to that found for the hands-on tests that were designed, administered, and evaluated as part of Project UTILITY (Vineberg and Taylor, 1972). The Project UTILITY tests were free of the defects that the GAO noted for the SQT.

In light of the GAO criticisms, it would be a mistake to attach too much significance to any individual result reported below for SQT performance in our four Army jobs. Nonetheless, the results should indicate, at least broadly, the nature of the relationships between observable entry characteristics and subsequent job performance. Until better performance measures are available,[7] the SQT should remain a serviceable tool for evaluating enlistment standards.

Table 2.3 gives the partial effects of each of a variety of entry characteristics, and time on the job, on the probability of passing the SQT for each of our four jobs. Details of the regressions on which these results are based are presented in App. D. The numbers indicate the effect of a unit change in the particular variable, for a person who has the mean value on all variables. Thus the AFQT result for 11B (Infantry), for example, indicates that the average enlistee would be 0.33 percentage points more likely to pass the SQT if his or her AFQT score were one point higher. To aid in the interpretation of these results, the means and standard deviations of each of the variables, for the enlistees in our sample, are given in Table 2.4.

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[6]Wagner et al. (1982) report that practice HOC runs are routine one week or less before the formal test.

[7]Each of the services has embarked on a major effort to improve its measurement of job performance; see OASD(MRA&L), 1981.

Table 2.3

EFFECTS OF INDIVIDUAL CHARACTERISTICS ON THE PERCENT PROBABILITY OF PASSING THE SQT FOR FOUR ARMY JOBS

| Characteristic | 11B | 31M | 36K | 91B |
|---|---|---|---|---|
| Aptitude area score[a] | 0.48[b] | 0.93[b] | 0.84[b] | 0.61[b] |
| AFQT | 0.33[b] | 0.43[b] | 0.57[b] | 0.21[b] |
| Months on job | 0.21 | 0.64[b] | 0.04 | 0.20 |
| Non-high-school graduate | -2.76 | -6.60 | 2.27 | -12.75[b] |
| Nonwhite | -9.85[b] | -6.04 | -7.73[b] | -10.50[b] |
| Predicted passing probability at means[c] | 80.92 | 23.59 | 54.56 | 65.58 |

[a]Specific aptitude area composites were: 11B--Combat Arms; 31M and 36K--Electronics; 91B--Skilled Technical.

[b]Based on regression coefficient that differs significantly from zero at the 5 percent level.

[c]Actual passing percentages differ slightly from predicted passing probabilities at the means because the estimated functional relationship is nonlinear.

The strongest effects, in terms both of magnitudes and of consistently significant coefficients, appear for the two test scores. A one-standard-deviation increase in the average enlistee's aptitude area score (10 to 13 points) raises the predicted probability of passing the SQT by 5 to 9 percentage points, depending on the job. Raising his or her AFQT score by one standard deviation (16 to 23 points) also increases the passing probability by 5 to 9 percentage points. Combining the two test score improvements, as might be more common in practice, raises the predicted probability of passing by 10 percentage points for 91B, 11 points for 11B, 16 points for 36K, and 23 points for 31M.

The effect of time on the job appears to be generally small, except for 31M (Radio). In that job, an average enlistee taking the SQT after 6 months on the job (the earliest point allowed) would be 7 percentage

Table 2.4

MEANS AND STANDARD DEVIATIONS OF VARIABLES

| | 11B | | 31M | | 36K | | 91B | |
|---|---|---|---|---|---|---|---|---|
| Characteristic | Mean | s.d. | Mean | s.d. | Mean | s.d. | Mean | s.d. |
| Aptitude area score | 92.13 | 13.33 | 91.83 | 10.98 | 90.13 | 9.60 | 103.57 | 10.70 |
| AFQT | 38.03 | 22.84 | 33.44 | 21.06 | 27.42 | 15.96 | 46.34 | 22.54 |
| Months on job | 17.97 | 6.50 | 18.87 | 6.08 | 16.84 | 6.40 | 15.94 | 6.57 |
| NHSG[a] | .3045 | .4603 | .2439 | .4296 | .2825 | .4504 | .2721 | .4452 |
| Nonwhite | .5505 | .4976 | .6959 | .4603 | .7056 | .4559 | .5210 | .4997 |
| Percent passing SQT | 76.50 | | 26.84 | | 53.48 | | 64.03 | |

[a]Non-high-school graduate.

points less likely to pass than at the 19-month point that was typical of our sample. Taking it after 30 months on the job, he or she would be 8 points more likely to pass than at 19 months.

Results for the two categorical variables—non-high-school graduate and nonwhite—are surprising. Even after controlling for general and job-specific aptitude, nongraduates have passing probabilities about 13 percentage points lower than graduates in 91B (Medical), and in all jobs being nonwhite seems to lower the probability of passing by about 6 to 10 points.

## QUALIFIED MAN-MONTHS

To make use of the two measures of performance, either in setting enlistment standards or in assigning people to jobs, we must combine them in some meaningful way so that we can examine the tradeoffs between high predicted performance on one measure and on the other. Graduation from high school is virtually the only indicator of success on the retention measure, but for SQT performance it is less important than high test scores. Which recruit should be preferred, then: a high-scoring nongraduate or a low-scoring graduate? Is there reason to make one an Infantryman, and the other a Medical Specialist? At least a partial answer to these questions is provided by a summary measure developed by Armor et al. (1982): qualified man-months.

A qualified man-month (QMM) is defined as a working (i.e., post-training) month contributed by an enlistee who is able to perform his or her job at least at the minimum acceptable level of competence. We cannot foretell any person's *actual* performance before he or she enlists, of course, but knowing the probabilities of retention at each month over the first tour, and of the enlistee's passing the SQT during each month, we can compute the *expected* number of QMM the enlistee will contribute. In all that follows, the term "qualified man-month" will be used in this probabilistic sense.

Table 2.5 gives the numbers of QMM per recruit in each of our four jobs, over the first 34 months of service, for the average recruit in each of several broad categories. These were first calculated for a finer breakdown of recruits into 280 categories for each job,[8] and then aggregated, using as weights the proportions of recruits in each category, entering each job, from among FY81 enlistees.[9]

Several comparisons are now possible.[10] The obvious differences dictated by both retention and SQT relationships are present; high-AFQT recruits are better than low-AFQT, high school graduates are better than nongraduates. However, the differences between high- and low-scorers, and between graduates and nongraduates, vary across the four jobs. Recall that 36K (Wireman) showed only a small difference between graduates and nongraduates in retention, and virtually no difference in SQT performance; this is reflected in the QMM figures, which show the smallest advantage for graduates in this job. Test scores had the greatest effect on SQT performance in 31M (Radio), a fact mirrored in the QMM numbers for this job, which show Category I-II recruits more than twice as productive as Category IV.[11] Even more interesting are comparisons involving both dimensions simultaneously. In particular, high-AFQT nongraduates seem to provide more QMM than do low-scoring graduates.[12] This advantage is greatest

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[8]AFQT scores were divided into seven discrete intervals, and each aptitude area score into ten intervals. Combined with the two education categories (high school graduate, nongraduate), and two race categories (white, nonwhite), this yields the 280 categories.

[9]Using weights based on FY77-FY80 recruit characteristics gives results only slightly different. The biggest differences occur in the low-AFQT groups, which had higher average scores in FY81 than in the earlier period.

[10]It was not feasible, unfortunately, to calculate standard errors for the numbers in Table 2.5, which are estimates.

[11]The difference is large partly because it combines AFQT and aptitude area differences in SQT performance. High scorers on the AFQT tend to have high scores on all the aptitude area composites.

[12]Given our inability to calculate standard errors, and the small sample of jobs examined, this conclusion is very tentative.

Table 2.5

QUALIFIED MAN-MONTHS PER RECRUIT, BY AFQT CATEGORY AND EDUCATION, IN FOUR ARMY JOBS

| MOS and Education | AFQT Category I-II | IIIA | IIIB | IV |
|---|---|---|---|---|
| *11B* | | | | |
| HS | 21.3 | 19.6 | 18.6 | 15.7 |
| NHS | 16.4 | 14.2 | 13.3 | 11.3 |
| *31M* | | | | |
| HS | 13.4 | 10.0 | 7.1 | 5.6 |
| NHS | 8.3 | 7.5 | 5.0 | 3.2 |
| *36K* | | | | |
| HS | 20.0 | 19.5 | 14.8 | 11.7 |
| NHS | 17.4 | 15.2 | 11.6 | 10.1 |
| *91B* | | | | |
| HS | 19.7 | 17.2 | 15.0 | 14.1 |
| NHS | 13.8 | 11.7 | 10.2 | 9.2 |

(48 percent more QMM) in 31M and 36K. Indeed, so sharp is the fall-off in SQT performance in these two jobs as AFQT declines that even the small difference in scores between the average Category IIIA and Category IIIB recruits is enough to offset the advantage in retention of graduates. For these two jobs, IIIA nongraduates apparently should be preferred to IIIB graduates.

The models described in Secs. IV and V apply these QMM results to yield indications of optimal enlistment standards and optimal assignments of recruits. Even at this point, however, some tentative conclusions can be drawn. First, the standard for selection to 31M should be high relative to the standards for other jobs, and it should receive relatively few nongraduates. Second, 36K can receive a relatively high proportion of nongraduates without greatly harming performance, but it too should require relatively high test scores. Finally, recruiting policies should favor the enlistment of high-aptitude recruits, rather than solely emphasizing high school graduates, unless it is much more expensive to recruit high-scoring nongraduates than low-scoring graduates. These precise conclusions might not have been drawn, of

course, from an analysis based on a better performance test than the SQT, but they illustrate the nature of the prescriptions that can emerge when attrition and job performance data are combined in a single measure.

## A CAUTIONARY NOTE

The relationships shown above between entry characteristics (principally ASVAB scores) and job performance are not insensitive to the choice of a passing score on the SQT. In general, reducing the passing score reduces the relative advantage of high-aptitude recruits over those with lower ASVAB scores, in terms of the probability of passing the SQT.[13] Similarly, raising the passing score increases the relative advantage of high-aptitude recruits.

This sensitivity may appear to be a consequence of our use of the binary pass/no-pass SQT outcome, but it is not. The same problem would arise were we to use actual SQT scores as cardinal measures of relative performance: assuming that a recruit with a score of 80, for example, is twice as productive as one with a score of 40. The problem in both cases is that changing the test difficulty, either directly or through a change in the passing score, alters the relationship between SQT success and entry test scores. Our use of the pass/no-pass outcome merely makes the dependence on test difficulty particularly obvious.[14]

Determining whether the SQTs for our four jobs were appropriately difficult was beyond the scope of this study. We note, however, that for one of the specialties, 31M (Radio), passing rates were particularly low (see Table 2.4). On the assumption that these low rates *may* have been caused by a too-difficult test (i.e., requiring knowledge of tasks that are seldom if ever required on the job), we have examined the effects of reducing the SQT passing score for this job from 60 to 50.

[13]For example, suppose that on some particular job 80 percent of individuals in AFQT Category I passed the SQT, and 40 percent of those in Category IV passed. If the passing score on the SQT were lowered from 60 (out of 100) to 50, the two passing rates might rise to 90 percent and 60 percent, respectively. Instead of being twice as likely to pass, the typical Category I recruit would be only one and one-half times as likely. Conversely, if the SQT passing score were increased to 70, the passing rates might fall to 60 percent 1 20 percent, yielding a relative advantage for Category I recruits of 3 times.

[14]Note that for all the results presented here, we do not make a pass/no-pass prediction for each recruit based on his or her entry characteristics. Rather, as suggested by the discussion of Table 2.3, we predict the *probability* that each one will pass the SQT. This makes drawing inferences about relative performance straightforward: If one person is twice as likely to pass the SQT as another, his or her *expected performance* is also twice as great.

The regression results for the alternative passing score do not bear reporting because they are broadly similar to those for the passing score of 60 (Table 2.3). The chief effect is to raise the passing probability for the average individual in 31M from 23.6 percent to 51.3 percent. Increasing the average recruit's AFQT score by one standard deviation still increases his or her probability of passing the SQT by about 9 points, but this is now an improvement of less than one-fifth instead of the more than one-third improvement under the established SQT passing score of 60.

In terms of qualified man-months, the effect of the lower SQT passing score is to narrow the difference between high- and low-aptitude recruits. Among high school graduates, Category I and II recruits outperform Category IV recruits by 15.9 QMM per recruit to 11.7. For nongraduates, the difference is 10.1 versus 7.1. These differences of less than one and one-half to one compare with the more than two-to-one difference with the established SQT passing score of 60 (Table 2.5). The implications of the narrower differences for the alternative passing score of 50 are discussed in Sec. IV.

# III. ENLISTMENT STANDARDS

In the discussion thus far, the term "enlistment standard" has occasionally come up, but it has not yet been defined. This omission has been deliberate, for a simple definition provides only a partial understanding of what enlistment standards are; equally important is an appreciation of what they do. In this section we describe two sets of formal enlistment standards, discuss other mechanisms that implicitly set informal standards, examine the purposes of both types of standards and what they accomplish, and present a specific assumption, used in Sec. IV, about exactly what happens when one type of formal standard is changed.

## FORMAL ENLISTMENT STANDARDS

The Army, like the other services, imposes four types of standards at two levels. The four types are aptitude, educational, physical, and moral. Each type is applied at the service-wide level to determine eligibility for enlistment, and at the job level to determine acceptance into specific jobs. Although the term "enlistment standard" is commonly used at both levels, a better term for the job level might be "job acceptance standard" or simply "job standard." Where confusion might arise, we use the latter term as appropriate in what follows.

Physical and moral standards are fairly important, accounting for almost 20 percent of those not accepted by the Army.[1] Job standards of these types are often more stringent than Army-wide standards; perfect color vision is required by some jobs, for example, and no drug convictions by others. Aside from noting this, however, we have not examined, or considered changes in, these two types of standards.[2]

This study is concerned with changes in the other two types of standards: aptitude and education. At the Army-wide level, the aptitude standard is set in terms of AFQT scores[3] in conjunction with educational level. At the present time, for example, no one scoring below the 16th percentile (Category IVB) on the AFQT is accepted, but non-high-school graduates must score above the 30th percentile (IIIB or

[1] Berryman, Bell, and Lisowski (1983).

[2] Chu and Norrblom (1974) discuss the effects of relaxing physical standards.

[3] The other services have used other standards as well—two aptitude area scores above 90, for example.

above). The precise definition of high school graduate has varied; GED holders have generally been considered nongraduates, but certificates of completion issued by some high schools have at times been accepted as equivalent to diplomas.

Job standards are set in terms of minimum scores on specific aptitude area composites. Table 2.1 gave the FY81 standards for a number of large jobs; these are repeated in Table 3.1 for the four jobs examined in detail in this study, along with the earlier standards. The latter are given both as they were stated at the time, and as they were later corrected with the ASVAB renorming.

## INFORMAL STANDARDS

Operating at the Army-wide level are several mechanisms that, both individually and collectively, do more to determine the character of entering recruits than do the formal standards. Probably the most important of these is the general recruiting environment—the ever-varying willingness of high-aptitude people and high school graduates to enter the military. This willingness cannot be considered part of the Army's standards, but it has sometimes directly affected the formal standards that the Army sets. During FY81, for example, recruiting

Table 3.1

JOB STANDARDS FOR FOUR ARMY JOBS

| MOS | Aptitude Area Composite | Minimum Score: Pre-FY81 Nominal | Pre-FY81 Renormed | FY81 |
|---|---|---|---|---|
| 11B | Combat | 90 | 76 | 85 |
| 31M | Electronics Repair | 90[a] | 76 | 95 |
| 36K | Electronics Repair | 90 | 76 | 90 |
| 91B | Skilled Technical | 100 | 84 | 95 |

[a]Some time during the second half of FY80 (available records do not indicate exactly when), the standard for 31M was raised to 100, equivalent to a 93 under the correct norms.

became so easy that the Army stopped accepting nongraduates in AFQT category IIIB.

In attempting to influence the recruiting environment, through the addition of recruiters or of advertising dollars, the Army is seeking to accomplish one of the purposes of a change in standards: to alter the quality mix of entering recruits (total enlistment goals are virtually always met). The formal mechanism through which changes in recruiting resources are translated into a change in the quality mix is the specification of detailed enlistment quotas for recruiters. Indeed, altered enlistment quotas may yield an altered quality mix even without a change in recruiting resources, though not necessarily in the desired direction (see Dertouzos, forthcoming). The ability of the recruiting command to affect the quality mix through recruiting resources and enlistment quotas suggests that these two policy levers together define an informal enlistment standard. A non-high-school graduate may be *allowed* to enlist, but if nothing is done to encourage him, or some measures actively taken to *dis*courage him, the effect will be very nearly the same as if nongraduates were not accepted at all.

At the job level, one role of formal standards is to put people in the jobs they are best qualified for. Because the standards are merely minimum acceptable scores, however, they cannot perform that function well, except perhaps for low-scoring recruits. Thus the Army's guidance counselors, who help the recruit choose a job (before the enlistment contract is signed), augment this allocative function. High-scoring recruits, for example, are discouraged from choosing jobs that require only low aptitude, and recruits who want to enter jobs for which they barely meet the standard, but have high aptitudes in other areas, are encouraged to choose jobs they are better qualified for. The Army is now building this function into the computerized job reservation system that the guidance counselor uses to match the individual's desires with the needs of the Army, so that one component of those needs will be how well the recruit's test scores suit him for each job.[4] In applying this criterion, whether directly through the computer system or indirectly through the training of the guidance counselors, the Army is using a set of informal standards. The formal job standards determine the set of jobs for which a person will be allowed to enlist; the informal standards influence the probability that he or she will choose any job within that set.

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[4]See the discussion of MOS Match Module, and planned future Army projects, in OASD(MRA&L), 1981. The feature is part of the Enlisted Training and Accession Management System (ETAMS), which was made operational in 1981, but does not play a major role in determining the jobs offered to the recruit. ETAMS is discussed further in Sec. V.

## WHAT STANDARDS DO

The Army's enlistment standards, both formal and informal, affect the quality mix—the mix of educational levels and of aptitudes as measured by test scores—among the recruits entering each job. Exactly how standards affect the quality mix, however, is not clear. We might expect that raising the Army-wide AFQT standard for high school graduates would raise the average AFQT score of recruits, but if the change makes it difficult for recruiters to meet their overall enlistment goals, we might observe them bringing in greater numbers of easy-to-find low-scorers and fewer high-scorers, or more nongraduates and fewer graduates. Similarly, raising the job standard for a job may cause it to be filled with recruits whose scores barely meet the new standard instead of with the broader mix it had received in the past. The interaction between formal and informal standards, and among standards, the preferences of recruits (including their willingness to enlist), and the incentives faced by recruiters and guidance counselors, make it hazardous to predict the quality-mix effects of altered standards.

To replace this indeterminancy we have adopted, for the enlistment standards model described in the next section, the rather strong assumption that Armor et al. (1982) called the *proportionality assumption*. Under this assumption, if a standard is raised for one job, the recruits who enter that job will look exactly like their counterparts in the pre-raise period whose test scores exceeded the new standard. This amounts to more than merely saying that some recruits are disqualified by the new standard, for if the number entering the job each year is to remain the same, the vacancies that remain unfilled because of disqualified recruits must somehow be filled by other recruits. Thus, the assumption may be viewed as a statement about where those recruits will come from and what their attributes will be. In the light of the discussion in the preceding paragraph, however, the proportionality assumption is really more than that simple statement. The changed standard may in principle affect the job choices not only of those who are disqualified, but of all the recruits who would have entered the particular job had there been no change in standards (and thus of all other recruits as well). If we are contemplating similar changes in the standards for all jobs, the proportionality assumption may be reasonably tenable, but to assess the effects of large increases in some standards and decreases in others, we would have to model more explicitly the other factors affecting job choices.

Although the proportionality assumption appears rather strong, that appearance partly stems from the oversimplified view of "standards" as

encompassing only formal standards. To use the assumption in prescribing a specific minimum score for some job would be going too far, but it can be used to aid in the description of an appropriate quality mix, or average quality level, for a given job. In practice, informal standards are likely to play an important part in achieving that quality level.

The enlistment standards portion of this study was specifically concerned only with the setting of job standards, but if we raise standards for very many jobs—as the results in Sec. IV suggest we should—we will also affect who will be allowed to enlist. That is, we will be changing the informal standards that apply at the Army-wide level. We will also be prescribing the appropriate quality mix for the Army as a whole. Indeed, this is one way to interpret the model results—not so much as indicating the optimal standards for specific jobs, but rather as suggesting what sorts of recruits the Army should be seeking.

# IV. SETTING JOB STANDARDS

The measurements of job performance in Sec. II give indications of what sorts of recruits the Army should prefer, other things being equal, but of course other things are not equal. The Army cannot fill all its jobs with Category I high school graduates (even if enough of them reached enlistment age each year), because to do so it would have to outbid all potential civilian employers for their services. This would be prohibitively expensive.[1]

To determine how far the Army should go in seeking to fill its ranks with the most desirable types of recruits, we must answer the question: How much does it cost to recruit, train, and retain each type? Given estimates of these costs, we can balance them against the expected contribution of each category of recruit—the number of qualified man-months (QMM) that the typical recruit in the group would produce.

Two types of cost/performance tradeoffs are important. First, the most productive categories of recruits—high-aptitude high school graduates—are also the most costly to recruit. Because the Army has deliberately limited the numbers of lower-aptitude and nongraduate recruits it has enlisted, an expansion of those numbers could come at little additional cost in terms of recruiting resources, special incentives, or reductions in the numbers of higher-quality recruits. Attracting more high-quality recruits, however, requires expending more resources. The higher costs must be balanced against the greater performance they yield. Second, two enlistees who produce equal numbers of QMM, and are equally costly to recruit, may impose different total costs over the working periods of their first tours. Ironically, the enlistee (a high-aptitude nongraduate, for example) who does not complete the first tour may be a better "buy" than a low-aptitude graduate who does (ignoring the Army's desire to retain some enlistees past the first tour). The former contributes his or her QMM early in the tour and then leaves; the latter may perform less than adequately, but stay in longer.

In this section we treat job acceptance standards as a tool for achieving the most cost-effective quality mix within each job and, by extension, for the Army as a whole. We apply the cost/performance tradeoff model developed by Armor et al. (1982), extended to handle several jobs simultaneously, to the problem of choosing job standards

[1]Turning to a draft would not eliminate these costs, but merely hide them. The costs would still be present in the form of the forgone civilian production the draftees would have contributed.

that minimize the cost of obtaining given levels of QMM. The model is applied in turn to data representing a poor recruiting year (recruit characteristics in FY77-FY80) and a good recruiting year (recruit characteristics in FY81). To set the stage for the model results, we first present cost data and assumptions for the four jobs described in Sec. II, then describe the Armor model, and finally discuss how we extended it.

## COSTS

All the cost data presented here pertain to *variable* costs: those components of total costs that vary with the number of enlistees. We exclude fixed costs because they do not affect the cost-minimization calculations made in the model to be described. All costs are associated with the first tour only, defined as the three-year tour that is typical of most Army enlistees.[2] Costs are measured in FY81 dollars, and pertain to changes in the numbers or types of recruits entering the Army in that year. We first discuss the costs of training and maintaining the enlistee through the first tour, lumping them together under the heading of "force costs," and then describe our assumption about recruiting costs.

### Force Costs

Figure 4.1 displays the cost profile for a recruit in 36K (Wireman), which is typical of our four jobs. Costs for the training period include costs for initial processing and clothing issue, and the average cost of discharge processing. For consistency across the four jobs, we define the training period as the first through the fifth month of active duty, which encompasses the actual training periods of the vast majority of the enlistees in our four jobs. Costs in succeeding periods include average pay and allowances, travel costs, and the variable portion of base support costs (assumed constant for all months). Costs rise over time as the typical recruit is promoted to higher grades.

Training costs loom large in the total first-term force costs of a typical recruit, accounting for more than 15 percent of the total for an

[2] More precisely, we measure costs over only the first 34 months. Many enlistees receive normal discharges slightly before the full 36 months of their obligations, which led to our choice of the 34-month cut-off. In addition, because Army policies with regard to longer and shorter tours have changed over time, we have ignored the complication presented by varying tour lengths by assuming that all recruits sign up for three years. A two-year enlistment option was not offered in FY77, the year of entry for the recruit sample on which are based the retention rates presented in Sec. II.

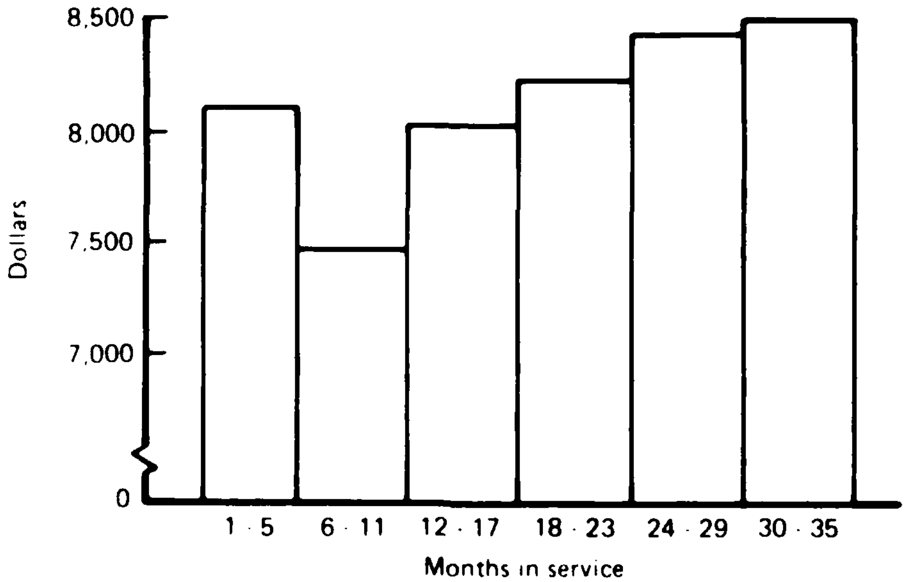


Fig. 4.1—Typical First-Term Force Costs (36K)

enlistee who stays 35 months. As a result, the average cost of a post-training month falls rapidly the longer the enlistee stays. An enlistee who stays only one year costs an average of $2403 per working month; that figure declines to $1915, $1746, and $1665, for stays of 18, 24, and 30 months.

## Recruiting Costs

Estimating the cost of recruiting is less straightforward than it is for force costs. Here we have had to rely on assumptions, guided by available studies of enlisted supply.[3] Three questions are involved: (1) What policy instrument will be used to bring in more recruits? (2) What is the enlistment response to changes in that instrument? and (3) How does the response differ across categories of recruits (or alter-

[3]Among the studies examined were Fechter (1970), Grissmer et al. (1974), Amey et al. (1976), Cooper (1977), Huck and Allen (1977), Grissmer (1978), Fernandez (1979, 1982), Haggstrom et al. (1981), Dale and Gilroy (1982), Goldberg (forthcoming), and Cotterman (forthcoming).

natively, what are the tradeoffs in recruiting among different categories)? The supply studies provide only partial, and conflicting, answers to these questions. They give least guidance on the last; all explore only supply relationships, and most, because of their focus on supply, limit their analysis to high-aptitude (typically, I-IIIA) high school graduates. As Dertouzos (forthcoming) points out, even for the high-quality group that the services would most like to recruit, the number of enlistments is driven not only by people's willingness to enlist, but also by the services' recruiting policies as reflected in their informal enlistment standards (see Sec. III). Thus, all these studies are suspect because they ignore the role of service demands, and implicitly rule out the possibility that more recruits of one category could be obtained, without the expending of additional resources, if some number (perhaps larger) of recruits in another category were given up. Unfortunately, it is much easier to point out these deficiencies than to correct them.

Faced with the conflicts and deficiencies of available studies, we have chosen as our policy instrument a change in pay, about the effects of which there seems to be greatest unanimity. To make this instrument cost-competitive with other instruments that, if we believe some authors, would be far more cost-effective than a general pay raise, we assume that the pay change would take the form of a bonus for high school graduates in AFQT Categories I-IIIA (not limited to four-year enlistees, as are current Army bonuses). We assume that these high-quality individuals would respond to the bonus as they would to a general first-term pay increase of equal present value, and that the elasticity of high-quality enlistments with respect to pay changes is constant and equal to 1.0.[4] The assumed pay elasticity is toward the lower end of the range reported in the various studies, but it has achieved some general acceptance—see, for example, the use of this value in Congressional Budget Office (1980).

For other groups—lower-scoring graduates and all nongraduates—we assume that the Army can alter the numbers of enlistments costlessly by manipulating informal enlistment standards; more high-scoring nongraduates can be obtained, for example, by relaxing the emphasis on recruiting graduates. Although this assumption of costless adjustment may seem extreme, our results tend not to be sensitive to small deviations from it. Conclusions about the relative cost-effectiveness of high-scoring nongraduates and low-scoring graduates, however, would

[4]That is, a 1 percent increase in pay brings in 1 percent more high-quality enlistees, regardless of the base number of enlistments.

obviously depend strongly on the assumed relative costs of acquiring enlistees in the two groups.

Table 4.1 shows the total variable, average variable, and marginal recruiting costs that result from the assumptions above, and our estimate of $150 million for baseline (no-increase) variable costs. The first panel, headed "Poor Recruiting Year," shows the costs that might have been predicted for FY81 based on data from the four preceding years. These costs reflect an assumed 30,000 base level of high-quality enlistments. The base level for the second panel ("Good Recruiting Year") is 44,000, the number of high-quality enlistments the Army actually received in FY81.

Two points are particularly worth noting in the table. First, although the average cost of a high-quality recruit is much lower for the high base than for the low, the total costs of obtaining a given *increment* differ very little. This follows from our assumption that the proportional response to a given pay increase is the same in both cases. Second, under both base-level assumptions, marginal costs (the cost of adding one more high-quality recruit) are higher than average costs. As a result, the average cost of a high-quality recruit rises with the number brought in. This has an important consequence, discussed below, for setting job standards in a multiple-job environment.

Table 4.1

VARIABLE RECRUITING COSTS IN FY81
(Dollars)

| | Poor Recruiting Year (Base = 30,000 recruits) | | | Good Recruiting Year (Base = 44,000 recruits) | | |
|---|---|---|---|---|---|---|
| Additional High-Quality Recruits | Total (000,000s) | Average | Marginal | Total (000,000s) | Average | Marginal |
| 0 | 150.0 | 5,000 | 20,800 | 150.0 | 3,409 | 20,800 |
| 2,000 | 194.4 | 6,074 | 23,573 | 193.5 | 4,206 | 22,691 |
| 4,000 | 244.3 | 7,185 | 26,347 | 240.8 | 5,016 | 24,582 |
| 6,000 | 299.8 | 8,327 | 29,120 | 291.8 | 5,836 | 26,473 |
| 8,000 | 360.8 | 9,494 | 31,893 | 346.7 | 6,666 | 28,364 |
| 10,000 | 427.3 | 10,683 | 34,667 | 405.3 | 7,505 | 30,255 |
| 12,000 | 499.4 | 11,891 | 37,440 | 467.7 | 8,351 | 32,145 |
| 14,000 | 577.1 | 13,116 | 40,213 | 533.9 | 9,204 | 34,036 |
| 16,000 | 660.3 | 14,354 | 41,987 | 603.8 | 10,064 | 35,927 |

The magnitude of the average bonus—equal to the actual bonus if bonus payments are not restricted to certain specialties—rises linearly with the number of additional recruits. Under the poor recruiting year assumptions, the average bonus rises by $693 for every 1,000 additional recruits, and by $473 under the good-year assumptions. The similarity in total costs for the two cases arises despite the differences in required bonus levels because bonuses must be paid to all high-quality recruits, not merely the added recruits.

## A COST/PERFORMANCE TRADEOFF MODEL

The model used in this study is based on the one developed by Armor et al. (1982). Here we give a formal description of the Armor model for the case of one job. The next subsection describes the extensions for the multiple-job case.

Let $p(i,j,k,m)$ be the probability that a randomly chosen recruit entering the job will have entry characteristics $i,j,k$, and $m$, where:

- $i$ = index denoting one of ten intervals (e.g., 90-94) of the range of scores on the aptitude area composite used for the job; 1 denotes the lowest interval and 10 the highest.[5]
- $j$ = index for AFQT category: 1 = IVC, 2 = IVB, 3 = IVA, 4 = IIIB, 5 = IIIA, 6 = II, and 7 = I.
- $k$ = index for education: 1 = high school graduate, 2 = nongraduate.
- $m$ = index for race: 1 = white, 2 = nonwhite.

We estimate the $p$'s from the actual proportions of enlistees who entered the job with each set of characteristics, excluding Category IV nongraduates (to reflect current Army formal enlistment standards). The proportions are taken alternatively from each of the two datasets described in Sec. II.

Expected costs and returns for recruits with characteristics $i,j,k$, and $m$ are denoted:

$q_{ijkm}$ - qualified man-months (QMM);

$r_{ijkm}$ - retained man-months, defined as post-training months;

$f_{ijkm}$ - force cost.

---

[5]Except for the bottom and top of the range, each interval covered five points. The bottom interval for 11B was 75 and below, and the top 115 and above. For the other jobs the bottom intervals were 79 and below, and the top 120 and above.

Let $A$ denote the number of enlistments in the job. Then the job totals for the cost and benefit variables, denoted by uppercase letters, are given by:

$$Q = A \sum_i \sum_j \sum_k \sum_m p(i,j,k,m) q_{ijkm}, \tag{1}$$

$$R = A \sum_i \sum_j \sum_k \sum_m p(i,j,k,m) r_{ijkm}, \tag{2}$$

$$F = A \sum_i \sum_j \sum_k \sum_m p(i,j,k,m) f_{ijkm}. \tag{3}$$

The number of high-quality recruits, $H$, is given by

$$H = A \sum_i \sum_{j \le 5} \sum_m p(i,j,1,m). \tag{4}$$

Baseline levels of all these variables, denoted by a superscript zero ($^0$), are calculated by replacing the $p$'s in the above equations with the probabilities calculated from the actual proportions of enlistees without excluding Category IV nongraduates.

Recruiting costs ($C$) are given by:

$$C = HE[(H/H^0) - 1] + C^0, \tag{5}$$

where $E$ is the present value of first-term earnings (estimated to be \$20,800) and $C^0$ is the baseline level of total variable recruiting costs. This equation follows from the recruiting cost assumptions, and was used to derive the figures in Table 4.1.[6]

## Changing the Standard

Let $i'$ indicate the job standard set at the bottom of the interval $i - i'$. Then under the *proportionality* assumption, the probability that a randomly chosen recruit entering the job will have characteristics $i, j, k$, and $m$, given that the standard is set at $i'$, is simply the conditional probability given $i \ge i'$:

$$p(i,j,k,m \mid i \ge i') = p(i,j,k,m) \Big/ \Big[ \sum_{i \ge i'} \sum_j \sum_k \sum_m p(i,j,k,m) \Big]. \tag{6}$$

[6] In the more general case of an arbitrary pay elasticity $\epsilon$, the ratio $H/H^0$ would be raised to the power $1/\epsilon$.

The levels of $Q, R, F$, and $C$ that result from a changed standard depend on the number of accessions into the job. Let $A(i')$ denote the number of accessions when the standard is set at $i'$. Because we hold the number of QMM constant at its baseline level ($Q^0$), $A(i')$ is found from Eq. (1) by setting $Q = Q^0$, replacing $p(i,j,k,m)$ with $p(i,j,k,m \mid i \geq i')$, and solving for $A$; i.e.,

$$A(i') = Q^0 / [\sum_i \sum_j \sum_k \sum_m p(i,j,k,m \mid i \geq i') q_{ijkm}]. \tag{7}$$

Values of $R(i')$, $F(i')$, and $C(i')$ are found from Eqs. (2) through (5), replacing the $p$'s with the conditional probabilities (6), and $A$ with $A(i')$. For example,

$$F(i') = A(i') \sum_i \sum_j \sum_k \sum_m p(i,j,k,m \mid i \geq i') f_{ijkm}. \tag{8}$$

The problem is to choose $i'$ such that $F(i') + C(i')$ is minimized.

## COST/PERFORMANCE TRADEOFFS WITH MULTIPLE JOBS

The problem as stated above is not precisely the same as that examined by Armor et al. (1982). Rather than hold QMM constant at its baseline level, they held retained man-months constant, reasoning that force manning considerations would not permit a reduction in the size of the force, even if the smaller force were as capable as the baseline force. They then chose the standard that minimized the *average* cost of a QMM, thus generating a force that was both more costly, and more productive, than the baseline force. This appears to be an *ad hoc* procedure, but they demonstrated that the standard so chosen is not very different from the one generated by minimizing costs while holding QMM constant; only force size and costs differ greatly.

Although the approach of Armor et al. has some appeal, it cannot be used when their model is extended to multiple jobs. To do so, we would have to aggregate QMM across jobs, which requires placing a relative value on performance in each job. Simply adding QMM implies a specific value judgment—performance is equally valuable in all jobs—that we were unwilling to make. Apart from the obvious problem that this is simply an opinion, it is unsatisfactory because we have no evidence that the Skill Qualification Test is an equally valid measure of performance in all jobs.

We avoid the problem of aggregation by holding the number of QMM constant at their baseline level in each job. In so doing, we accept the valuation of the importance of our four jobs that the Army has implicitly made in its assignment of recruits to jobs, but make no statement about the importance of improving performance in one job, relative to improvement in another. We do not entirely reject the argument of Armor et al. that force size cannot be altered, however, and so also explore the implications for costs of choosing optimal standards given higher than baseline levels of QMM.

### Minimizing Costs with Multiple Jobs

Given our decision to hold QMM constant, the extension of the Armor et al. one-job model to the case of several jobs is fairly straightforward. With $N$ jobs the problem becomes (using subscripts to denote jobs):

$$\begin{aligned} &\underset{i_1, i_2, \ldots, i_N}{\text{Minimize}} \quad C(H(i_1, \ldots, i_N)) + \sum_n F_n(i_n) \\ &\text{subject to:} \quad Q_n(i_n) = Q_n^0, \text{ for } n = 1, \ldots, N , \end{aligned} \tag{9}$$

where $H(i_1, \ldots, i_N) = \sum_n H_n(i_n)$.

Note that recruiting costs cannot be decomposed into job-specific components, as can force costs, because the average cost of a high-quality recruit rises with the number brought in. Thus, there is no single "price" for a high-quality recruit. Moreover, if the standard is raised for job n, increasing its requirement for high-quality recruits, the average cost of high-quality recruits is increased not only for that job, but for every other job as well. This forces us to examine all standards *simultaneously*.

Our strategy for solving the optimal programming problem specified by Eqs. (9) and (10) is iterative. Starting from some initial set of standards, we explore changes in the standard of each job in turn, seeking in each case the standard that minimizes total costs, given the standards of the other jobs (and subject, of course, to the constraints of Eq. 10). When a pass through all the jobs reveals no new changes in standards, the process stops.[7]

[7]Although there is no assurance that this process will converge to a solution, or yield a unique solution, convergence always came quickly in our experiments, and the solution was insensitive to the starting values of the standards.

## Representing the Force

One further modification to the procedures described above is necessary before the model can be applied to the data for our four jobs. As the model is structured, it requires data on all Army jobs. To apply it to our four jobs alone would be to assume that they together comprise the entire force. Instead, we use the four to represent the force, weighting the costs, benefits, and entry characteristics of each so that their weighted sums give an approximation of the situation faced by the Army as a whole.

Table 2.1 gave indications of where our four jobs ranked, in terms of the quality of their FY81 enlistees, among the largest Army specialties. Table 2.2 showed the distributions of enlistees in our jobs by high school status and AFQT category, for both the FY77-FY80 and FY81 periods. As noted above, we take the former to represent a poor recruiting year, and the latter a good year. Working from both sets of data, and an informal examination of job tasks, we selected percentages of the force to be represented by each of our jobs, as follows: 11B (Infantry)—42 percent, 31M (Radio)—8 percent, 36K (Wireman)—22 percent, and 91B (Medical)—28 percent. In selecting these percentages, we attempted to match the two constructed *hypothetical* forces—one for a poor recruiting year, the other for a good recruiting year—to the actual distributions of entry characteristics for the entire Army during the FY77-FY80 and FY81 periods, respectively. Table 4.2 shows how close we came.

We fit the actual data quite closely for the FY81 period, generating slightly too high a percentage of nongraduates, particularly in the higher AFQT categories. The fit for the earlier period was not as good; although we matched the actual high school graduate percentage very well (57.5 percent of the hypothetical force, versus 56.9 actual), our hypothetical force is too heavily concentrated in the lower AFQT categories.[8] Our hypothetical force for the earlier period does much better, however, at representing the actual force of FY80, and so should provide a reasonable basis for examining possible changes between that year and the next, which is the use we make of it.

The baseline levels of enlistments in the four jobs and in the Army as a whole, and the percentages given above, yield the required weights for aggregating costs and benefits in the model.[9] Letting $w_n$ denote the

[8]In part this poorer fit was a result of our desire to use the same weights for both periods. More important, however, was the simple fact that in the earlier period only one of our jobs, 91B, was above the Army average in the quality of its recruits.

[9]Assumed baseline enlistments in the four jobs are: 11B—12,168, 31M—2,075, 36K—2,486, and 91B—3,329. Total Army enlistments (contracts) in FY81 were approximately 130,000. The weights are: 11B—4.4872, 31M—5.0120, 36K—11.5044, and 91B—10.9342.

Table 4.2

PERCENT DISTRIBUTION OF ARMY ENLISTEES BY AFQT CATEGORY AND HIGH SCHOOL STATUS: ACTUAL AND HYPOTHETICAL

| | AFQT Category | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | I-II | IIIA | IIIB | IV | I-II | IIIA | IIIB | IV |
| Force | Poor Recruiting Year | | | | Good Recruiting Year | | | |
| *Actual*[a] | | | | | | | | |
| HS | 13.4 | 7.4 | 10.7 | 25.4 | 20.9 | 12.5 | 19.4 | 24.6 |
| NHS | 4.6 | 5.8 | 11.7 | 20.9 | 3.8 | 4.8 | 12.7 | 1.2 |
| *Hypothetical* | | | | | | | | |
| HS | 10.8 | 7.0 | 10.9 | 28.8 | 21.4 | 12.6 | 17.6 | 22.8 |
| NHS | 3.9 | 4.7 | 10.8 | 23.1 | 4.9 | 5.5 | 13.6 | 1.7 |

[a]Actual data for the poor recruiting year are averages of accessions over the period FY77-FY80; for the good year the actual data reflect FY81 contracts.

weight for job $n$, total (Army-wide) high-quality requirements are given by:

$$H_T(i'_1, \ldots, i'_N) = \sum_n w_n H_n(i'_n). \tag{10}$$

The objective function specified in Eq. (9) becomes:

$$C(H_T(i'_1, \ldots, i'_N)) + \sum_n w_n F_n(i'_n). \tag{11}$$

## MODEL RESULTS

The model was run twice for each set of data (poor and good recruiting years). In both runs the constraint was constant QMM in each job, but the runs differed in the QMM levels selected. In the first, baseline levels were used; in the second, higher levels. Specifically, the higher QMM levels were those that resulted from increasing accessions in each job from their baseline levels until the numbers of retained man-

months (RMM) generated by the optimal standards equaled the baseline RMM totals. For example, if in the first run the optimal standard for one job resulted in a 20 percent reduction in RMM, then in the second run we started from a level of accessions (and RMM) 25 percent higher $(1.25 \times 0.8 = 1.0)$. Occasionally, the higher starting level of accessions led to a change in the optimal standard generated by the model, in which case we made a further adjustment.

One additional constraint was added in all the runs. Preliminary runs indicated that the performance parameters and entry characteristics of some jobs were likely to lead to unreasonably high optimum standards in the model. 31M was the worst job in this respect; the estimated performance payoff to higher test scores is so great in this job that the model consistently generated a standard of 120, the highest level we considered. This seems more likely to reflect a problem with the performance measure (SQT) for this job than any true need for extremely high-aptitude recruits (see "A Cautionary Note" in Sec. II). Thus, to avoid imbedding this anomalous result in our illustrative prescriptions for the Army as a whole,[10] we arbitrarily constrained the model not to allow standards to rise above 100, the highest level currently used by the Army in any of the large jobs listed in Table 2.1, and at least five points higher than the current standards of any of our four jobs.[11]

For each of the two recruiting environments (poor and good), we present two types of results. First are the job-specific results: Where should standards be set, and what are the implications for the numbers and quality of recruits required by each job? Second are the results for the Army as a whole, as represented by our hypothetical forces. These include overall AFQT/HS distributions of recruits and estimated costs.

## Optimal Standards and Performance in Four Jobs

Table 4.3 reports model results for the four jobs in a poor recruiting year, and the baseline conditions. The table shows standards, accessions (both total and the numbers of costly-to-recruit, high-quality enlistees), QMM and RMM, and the ratio of QMM to total accessions. The baseline standards are not exactly those that were in use in FY77-FY80; in adding the three new jobs to the one (11B) that Armor et al. examined, we simplified the computer programming of the model by choosing to work from a uniform baseline standard. This should

[10] Through its effect on recruiting costs, the high standard would have affected standards in the other jobs.

[11] Standards higher than 100 are common only in electronics repair and intelligence specialties.

## Table 4.3

**MODEL RESULTS FOR FOUR JOBS (POOR RECRUITING YEAR)**

| MOS | Standard[a] | Accessions Total | Accessions HQ | Man-months Qualified | Man-months Retained | QMM/ Recruit |
|---|---|---|---|---|---|---|
| | | | *Baseline* | | | |
| 11B | 76 | 12168 | 2133 | 180559 | 227900 | 14.8 |
| 31M | 80 | 2075 | 245 | 9086 | 37965 | 4.4 |
| 36K | 80 | 2486 | 198 | 28787 | 52374 | 11.6 |
| 91B | 80 | 3329 | 911 | 47005 | 73319 | 14.1 |
| | | | *Baseline, FM*[b] | | | |
| 11B | 76 | 11014 | 2705 | 180559 | 219914 | 16.4 |
| 31M | 80 | 1758 | 281 | 9086 | 34027 | 5.2 |
| 36K | 80 | 2352 | 250 | 28787 | 51501 | 12.2 |
| 91B | 80 | 3155 | 984 | 47005 | 70674 | 14.9 |
| | | | *Optimized, Baseline QMM* | | | |
| 11B | 85 | 10539 | 3278 | 180559 | 207084 | 17.1 |
| 31M | 100(120) | 956 | 338 | 9086 | 16662 | 9.5 |
| 36K | 100(110) | 1703 | 537 | 28787 | 36156 | 16.9 |
| 91B | 100 | 2866 | 1325 | 47005 | 64272 | 16.4 |
| | | | *Optimized, Higher QMM* | | | |
| 11B | 80 | 11511 | 3213 | 193676 | 227893[c] | 16.8 |
| 31M | 100(120) | 2178 | 769 | 20703 | 37964 | 9.5 |
| 36K | 100(105) | 2467 | 778 | 41698 | 52373 | 16.9 |
| 91B | 90 | 3275 | 1072 | 49419 | 73316 | 14.5 |

[a]Optimum standards were constrained not to exceed 100. Where two numbers are given, the second is the true optimum reported by the model. Actual standards (renormed) during the FY77-FY80 period were: 11B--76; 31M--76; 36K--76; 91B--84.

[b]Fixed marginal (Category IV nongraduates set to zero).

[c]Retained man-month totals in the "higher QMM" panel are not exactly the same as those in the baseline case because of rounding in the model inputs.

have no effect on the results for 91B because the actual standard for that job was slightly higher (84), and only a minor effect for the other two jobs.

Looking first at the top panel, we see again that 31M (Radio) was unusual in having very low average performance. Less than one-fourth of RMM was contributed by enlistees who were able to pass the SQT for that job. In part this is due to the low passing rate among even high-scoring recruits, but it also reflects the low percentage of recruits in that job who were high-quality. (See also the discussion at the end of this section.) We saw above (Table 2.3) that high-scoring recruits had a greater advantage over low-scorers in this job than in the other jobs.

The second panel shows the effect of simply eliminating Category IV nongraduates, the least productive group of recruits on both attrition and SQT measures.[12] The improvement in average performance (QMM per recruit) resulting from this change is greatest in absolute terms for 11B (Infantry), the job that initially had the highest percentage of recruits in this category. A greater percentage improvement in QMM per recruit is shown, however, by 31M, which also shows the largest percentage drop in the number of recruits needed to maintain the baseline level of QMM.

The baseline levels of performance can be more cheaply obtained if the standards in all four jobs are raised, as shown in the third panel. 31M requires only a few more of the costly high-quality recruits (and a corresponding number of high-scoring nongraduates[13]) to replace a large number of low-scorers. The smallest increase in a standard occurs for 11B. In part this is because of the performance relationships for that job; even a 21 percent increase in the number of high-quality recruits entering that job (and a 27 percent increase in the proportion of high-quality), relative to the second panel, brings only a small increase in the average level of performance. Equally important, however, is that this one job represents 42 percent of our hypothetical force, so that its cost conditions have a large impact on costs for the total force.

The last panel shows the results when the number of recruits entering each job is made large enough so that each has a force size (RMM) at the optimum standard that is the same as in the baseline case.

[12]The Army never intended to accept these recruits; it did so only inadvertently because of the incorrectly normed ASVAB.

[13]Compared with the other jobs, 31M had at the baseline a high ratio of nongraduates to graduates among its higher-scoring recruits. Thus, as the 31M standard is raised, that job tends to get a larger than average proportion of its improved performance from enlistees who are assumed to be costless to recruit.

Optimum standards are reduced in three of the four jobs by the increase in the required level of QMM.[14] For 91B (Medical), this occurs primarily because the cost curve for this job is very flat in the range 85 to 100, so that a small change in conditions can result in a large change in the optimum standard. For the other two jobs whose optimal standards are reduced, the reduction can be traced to the increases in recruiting costs that maintaining the higher standards would require. In 36K (Wireman), this is due to the large increase in accessions required to return RMM to its baseline level; in 11B, it results from the big impact this one job has on total-force costs.

The poor recruiting year results indicate how standards should have been set given conditions as they appeared at the end of FY80. Table 4.4 shows how very different conditions actually were in FY81. Every job had more QMM than the earlier data would have predicted and thus, given the same assumed baseline accession levels, greater average performance. The most dramatic improvement occurred for 31M: an almost twofold increase. All the improvements can be traced directly to the greater numbers of high-scoring recruits received by each job, and by the entire Army, which came without the large increase in recruiting costs that would have been predicted the year before.

What are the implications of the costless improvement in recruit quality for optimal standards? It might be thought that better-quality recruits would permit even higher standards, but this turns out not to be the case. Remember that the principal role played by standards is to set the quality mix entering the Army as a whole and specific jobs. The average quality of FY81 enlistees was considerably higher than what was sought by the model based on data from the earlier period; QMM per recruit are greater in the FY81 baseline than in the optimum standards cases from the earlier period in three of our four jobs. As a result, no further increases in standards appear warranted.

An additional reason for the lack of change is the Army's increased emphasis on recruiting high school graduates in FY81. Given our proportionality assumption, this means that the additional high-scoring recruits required when standards are raised tend to consist of greater proportions than before of high school graduates, who under our recruiting cost assumption are more costly than nongraduates. This is particularly true of 36K, the one job with a lower optimal standard in the good recruiting year case. In FY81 it actually had a smaller percentage of its recruits in the high-AFQT nongraduate groups than before.

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[14]None of our test runs yielded a lower optimum standard for 31M.

## Table 4.4

### MODEL RESULTS FOR FOUR JOBS (GOOD RECRUITING YEAR)

| MOS | Standard[a] | Accessions Total | Accessions HQ | Man-months Qualified | Man-months Retained | QMM/ Recruit |
|---|---|---|---|---|---|---|
| | | | *Baseline* | | | |
| 11B | 76 | 12168 | 4487 | 212785 | 240865 | 17.5 |
| 31M | 80 | 2075 | 724 | 17371 | 35966 | 8.4 |
| 36K | 80 | 2486 | 284 | 32835 | 54555 | 13.2 |
| 91B | 80 | 3329 | 1568 | 53234 | 74682 | 16.0 |
| | | | *Baseline, FM*[b] | | | |
| 11B | 76 | 12088 | 4541 | 212785 | 240272 | 17.6 |
| 31M | 80 | 2062 | 727 | 17371 | 35806 | 8.4 |
| 36K | 80 | 2467 | 290 | 32835 | 54402 | 13.3 |
| 91B | 80 | 3322 | 1572 | 53234 | 74581 | 16.0 |
| | | | *Optimized, Baseline QMM* | | | |
| 11B | 85 | 12061 | 4547 | 212785 | 239519 | 17.6 |
| 31M | 100(120) | 1776 | 769 | 17371 | 30504 | 9.8 |
| 36K | 95 | 2039 | 646 | 32835 | 43988 | 16.1 |
| 91B | 100 | 3136 | 1765 | 53234 | 70920 | 17.0 |
| | | | *Optimized, Higher QMM* | | | |
| 11B | 85 | 12128 | 4572 | 213974 | 240858[c] | 17.6 |
| 31M | 100(120) | 2095 | 907 | 20485 | 35973 | 9.8 |
| 36K | 95 | 2528 | 801 | 40720 | 54552 | 16.1 |
| 91B | 100 | 3303 | 1859 | 56065 | 74691 | 17.0 |

[a]Optimum standards were constrained not to exceed 100. Where two numbers are given, the second is the true optimum reported by the model. Actual standards during FY81 were: 11B--85; 31M--95; 36K--90; 91B--95. Some recruits apparently entered these jobs despite having scores below the minimum.

[b]Fixed marginal (Category IV nongraduates set to zero).

[c]RMM totals in the "higher QMM" panel are not exactly the same as those in the baseline case because of rounding in the model inputs.

Looking at the higher-QMM panel, we see that the larger implied force size does not lead to a reduced standard for any of our jobs. The reason for this is simple: The optimum standards under the baseline QMM case led to only small reductions in the numbers of recruits entering each job (and hence in RMM), so the rising cost of recruiting additional high-quality enlistees can be absorbed without any changes in standards.

The model results for both good and poor recruiting years yield the same conclusions about the proper levels of job standards. Current standards appear to be slightly too low generally, about five points. Given the various assumptions underlying the results, however, this conclusion should be taken only as illustrative of what the model can yield, rather than as a prescription for change. It must be noted, in addition, that the model calls for no increase in the standard for 11B, which we have taken to be typical of 42 percent of the entering force. Moreover, part of the role that the standards for our four jobs play in the model is to set the Army-wide quality mix among entering recruits. The improvement in overall quality that our results suggest is appropriate could probably better be achieved through a tightening of standards at the enlistment point. Finally, we have not examined the allocative role played by job standards, but it seems likely that as overall recruit quality improves, job standards should be raised simply to improve their functioning in this role.

## Army-Wide Quality Mix and Costs

As important as the job-specific results are the implications for the Army-wide quality mix and the costs (or savings) that follow from adopting higher standards. Tables 4.5 and 4.6 give the distributions of enlistees by AFQT category and high school status, for the poor and good recruiting years, respectively, under the various cases shown in the previous tables.

Looking first at the poor recruiting year results, we see that simply eliminating Category IV nongraduates had a marked effect on the quality mix. Army-wide, this raised the proportion of enlistees with above average AFQT scores (Category IIIA and above) from 26 to 34 percent, and reduced the percentage of low-scorers (Category IV) from 52 to 38 percent. Raising the job standards to their optimum levels resulted, under the baseline QMM case, in a further increase in above-average enlistees to 46 percent. Job-specific results indicate that most of this increase in overall quality should be directed toward improving the quality mix in the low- to moderate-skill noncombat specialties represented in our four-job sample by 31M and 36K.

Table 4.5

PERCENT DISTRIBUTION OF ENLISTEES BY AFQT CATEGORY AND HIGH SCHOOL STATUS: BASELINE AND OPTIMIZED
(Poor Recruiting Year)

| High School Status | I-II | IIIA | IIIB | IV | Total |
|---|---|---|---|---|---|
| | | | *Baseline* | | |
| HS | 10.8 | 7.0 | 10.9 | 28.8 | 57.5 |
| NHS | 3.9 | 4.7 | 10.8 | 23.1 | 42.5 |
| Total | 14.7 | 11.7 | 21.7 | 51.9 | |
| | | | *Baseline, FM*[a] | | |
| HS | 13.8 | 8.9 | 14.0 | 38.0 | 74.6 |
| NHS | 5.0 | 6.2 | 14.2 | 0.0 | 25.4 |
| Total | 18.8 | 15.1 | 28.2 | 38.0 | |
| | | | *Optimized, Baseline QMM* | | |
| HS | 19.3 | 11.1 | 15.0 | 22.3 | 67.7 |
| NHS | 7.5 | 8.5 | 16.3 | 0.0 | 32.3 |
| Total | 26.8 | 19.6 | 31.3 | 22.3 | |
| | | | *Optimized, Higher QMM* | | |
| HS | 18.3 | 10.7 | 14.6 | 24.8 | 68.4 |
| NHS | 7.4 | 8.4 | 15.8 | 0.0 | 31.6 |
| Total | 25.7 | 19.1 | 30.4 | 24.8 | |

[a]Fixed marginal (Category IV NHS set to zero).

The baseline distribution for the good recruiting year is very close to the optimum-standards distributions of the poor year. Percentages by AFQT category are virtually identical, so it is the greater high school graduate percentage that accounts for the improvements in performance reported in Tables 4.3 and 4.4. Eliminating Category IV non-graduates has little effect (second panel) because so few of them entered in FY81. The optimum standards generated in the model result in some increase in AFQT scores, but the change is much less marked than for the poor-year data.

Table 4.6

PERCENT DISTRIBUTION OF ENLISTEES BY AFQT CATEGORY AND HIGH SCHOOL STATUS: BASELINE AND OPTIMIZED

(Good Recruiting Year)

| High School Status | I-II | IIIA | IIIB | IV | Total |
|---|---|---|---|---|---|
| | | *Baseline* | | | |
| HS | 21.4 | 12.6 | 17.6 | 22.8 | 74.4 |
| NHS | 4.9 | 5.5 | 13.6 | 1.7 | 25.6 |
| Total | 26.3 | 18.1 | 31.2 | 24.5 | |
| | | *Baseline, FM*[a] | | | |
| HS | 21.7 | 12.8 | 17.8 | 23.3 | 75.6 |
| NHS | 4.9 | 5.5 | 13.9 | 0.0 | 24.3 |
| Total | 26.6 | 18.3 | 31.7 | 23.3 | |
| | | *Optimized, Baseline QMM* | | | |
| HS | 27.4 | 14.9 | 16.1 | 14.2 | 72.5 |
| NHS | 6.3 | 6.9 | 14.3 | 0.0 | 27.5 |
| Total | 33.7 | 21.8 | 30.3 | 14.2 | |
| | | *Optimized, Higher QMM* | | | |
| HS | 27.0 | 15.0 | 16.1 | 14.3 | 72.3 |
| NHS | 6.3 | 6.9 | 14.5 | 0.0 | 27.7 |
| Total | 33.3 | 21.9 | 30.6 | 14.3 | |

[a]Fixed marginal (Category IV NHS set to zero).

Table 4.7 shows what happens to the cost of recruiting and maintaining our hypothetical first-term forces under the various cases. The table shows clearly where the cost savings come from that make higher standards optimal in the baseline QMM case: Higher recruiting costs are offset by savings in nonrecruiting costs that are generated by the smaller numbers of recruits needed to maintain total performance. Based on the poor recruiting year data, the potential cost saving from the adoption of our optimal standards, and the indicated reduction in force size, would be on the order of $700 million per year. With a

Table 4.7

ACCESSIONS AND VARIABLE COSTS OF HYPOTHETICAL FORCE: BASELINE AND OPTIMIZED

| Case | Accessions | High Quality | Variable Costs ($000,000) Recr | Non-recr | Total |
|---|---|---|---|---|---|
| | | *Poor Recruiting Year* | | | |
| Baseline | 130000 | 23038 | 150[a] | 4506 | 4656 |
| Baseline, FM[b] | 119789 | 27182 | 150 | 4309 | 4459 |
| Optimized, baseline QMM | 103011 | 37069 | 332 | 3647 | 3979 |
| Optimized, higher QMM | 126759 | 38942 | 391 | 4488 | 4879 |
| | | *Good Recruiting Year* | | | |
| Baseline | 130000 | 44175 | 150 | 4630 | 4781 |
| Baseline, FM[b] | 129281 | 44545 | 158 | 4617 | 4775 |
| Optimized, baseline QMM | 120768 | 50988 | 314 | 4294 | 4608 |
| Optimized, higher QMM | 130120 | 54603 | 418 | 4632 | 5050 |

[a]Baseline recruiting costs are estimated actual costs, not the computed costs of recruiting the given numbers of high-quality recruits. Recruiting costs are the same in the first two cases because high-quality enlistments in both cases were fewer than 30,000, the number assumed to be available based on the FY77-FY80 data (see text).

[b]Fixed marginal (Category IV NHS set to zero).

better recruiting environment the potential savings are more modest—about $170 million. To realize the savings in either case, however, the Army would have to accept our performance data as indicating the actual useful output of first-term enlistees. We implicitly assume that there are no benefits from merely having recruits present that would offset poor job performance (as measured by the SQT).

The case for the optimality of higher standards is much less clear if force size must be maintained at its current level. Our "higher QMM" case corresponds to an increase in QMM that averages about 25 percent in the poor recruiting year case, and about 8.5 percent in the good-year case. Achieving that performance increase would cost, given our assumptions about how it would be accomplished, about $220 million (poor year) to $270 million (good year).[15] Taking the latter as most

[15]It may seem odd that the added costs are higher in the good recruiting year case than in the poor-year case. This occurs because in the poor-year case the requirement for greater force size (RMM) causes reductions in the standards for two jobs, which

appropriate for decisions today, it appears that the 8.5 percent increase in performance would add about 5.6 percent to the variable cost of recruiting and maintaining one year's recruit cohort through a three-year first tour. Whether the benefits in terms of better job performance justify the higher costs is beyond the scope of this study.

One limitation of all the results should be borne in mind. We have examined costs and performance only during the first tour, but changing enlistment standards and the first-term force size may have consequences for the numbers and types of enlistees in the career force. The types of enlistees could change because raising standards would raise the average quality of enlistees reaching the first reenlistment point. Thus, career-force job performance could improve, a benefit of higher standards that we have not considered. Higher-aptitude enlistees, however, could be less (or more) likely to reenlist than their counterparts during periods of lower standards, which would reduce (increase) the numbers of reenlistees given unchanged compensation and reenlistment policies. Fewer reenlistees should certainly be expected if the first-term force size were reduced. We have shown that a smaller first-term force could, given higher standards and under certain assumptions, replace a larger force of less-capable recruits, but we can offer no assurance that the same would be true, or true to the same extent, in the career force. Considering only the first-term force reduces the problem of setting optimal standards to manageable proportions, but in the practical application of our methods (or any others) the career force implications should not be ignored.

### Results Under Alternative SQT Passing Score for 31M

In Sec. II we discussed the effects on performance tradeoffs of changing the standard for acceptable performance on the 31M Skill Qualification Test. Making the test easier by lowering the passing score from 60 to 50 reduces the advantage, in terms of QMM, of high-aptitude recruits over those with low ASVAB scores. In general, such a change could be expected to affect markedly the results generated by the cost/performance tradeoff model. In this particular case, however, the effects are modest, largely because of the imposed constraint that no job standard exceed 100. As shown above in Tables 4.3 and 4.4, the cost-minimizing standard for 31M was consistently found to be 120.

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reduces those jobs' requirements for costly high-quality recruits. In addition, the smaller proportion of non-high-school graduates in the good recruiting year case means that relatively little of the required performance increase (higher QMM) can be achieved through the assumedly costless addition of high-aptitude nongraduates.

With the alternative SQT passing score, the cost-minimizing standard tends to fall, in one case (good recruiting year, higher QMM) to 100. This by itself has no effect on the overall results, however, because of the imposed constraint.

Where changes do occur is in the QMM and accession totals for 31M. In the poor recruiting year case, the higher SQT passing rates result in a baseline QMM level of 17,940, instead of 9,086 (Table 4.3). In the good-year case, the increase is from 17,371 (Table 4.4) to 25,744. The reduced advantage of high-aptitude over low-aptitude recruits limits the potential for achieving given QMM levels with fewer recruits. Thus, in the "baseline QMM" model results (third panel in Tables 4.3 and 4.4), the accession levels required by 31M are greater than before, even though the job standard is the same. This raises nonrecruiting costs and, because the high-quality requirement is increased proportionately, recruiting costs as well. In the poor recruiting year case the increase in recruiting costs results in a secondary effect: The optimal standard for one other job (91B) is reduced slightly, from 100 to 95 (recall that the model deals with standards at five-point intervals, so this is the smallest change possible). As noted above, the cost curve for 91B is quite flat with respect to changes in its standard, so it is not surprising that this job would be the first to feel the effects of a change in marginal recruiting costs. The changes in 31M's accession requirements are smaller in the case of the good recruiting year, yielding no changes in other jobs' standards.

The limited impact of the alternative passing score in this particular application of the cost/performance tradeoff model is no assurance that there would not be more significant effects in other applications. Indeed, the rather large change in the cost-minimizing standard for 31M—which because of the imposed constraint could not have any appreciable effect on the overall model results—indicates that even seemingly small changes in the difficulty of performance tests could markedly affect the optimal levels of job standards. This sensitivity should be recognized as attempts are made to link entry standards to job performance, whether that link is through this model or takes some other form. Test developers must understand both the uses to which the results of their tests will be put and the importance of ensuring that the levels of difficulty they choose accurately reflect job requirements.

# V. MATCHING RECRUITS TO JOBS

In Section IV we posed the question: Can job performance be improved, or costs reduced, if enlistment standards are raised? The answer, we found, is ambiguous; higher standards can save money, and maintain performance, if the Army accepts a smaller force. If the force size cannot be reduced, then higher standards will improve performance, but not without cost.

Here we explore the possibilities for improving overall job performance through a better matching of recruits to jobs. Our performance measure—QMM per recruit—gives us a tool for examining the person/job match that has not been available to Army planners. We have two sets of data on actual matches—one from a good recruiting year, the other from leaner times—and we can compare the job performance those matches have generated with what could have been obtained had the information been available on the relationships we have found between entry characteristics and performance.

Our intention is not to sit in judgment of the Army's matching system. We make optimal assignments for an entire one-year cohort at once, taking no account of the day-to-day constraints under which the Army must operate. If these optimal assignments were to generate dramatic improvements in performance—20 percent or more, for example—it would create a clear presumption that the introduction of job performance information at the matching point would be worth the effort it would entail. If the improvements were smaller, however—under 10 percent, perhaps—we might suspect that they were attributable largely to our abstracting from the institutional realities. Not only do we ignore the Army's need to fill training seats at specific times of the year, but also we assume that recruits' job preferences are compatible with the assignments we generate. Ours is, in short, a limited analysis of job matching, but one that nonetheless yields useful results.

## JOB PERFORMANCE INFORMATION AND JOB MATCHING

The Army currently has only limited information available to help it match recruits to jobs; for any given job, recruits who score highly on certain subtests of the ASVAB are more likely to perform well than those who score well on other subtests. This information is made operational in the Army's choices of specific aptitude area composites

for setting standards in individual jobs, and plays a more limited role in determining the set of jobs, from among those for which the recruit qualifies, that will be offered (or suggested) to the recruit.[1] To this information our performance measure adds three additional items: (1) *how strong* the relationship is between specific aptitudes and performance in each job, (2) how important *general aptitude* (AFQT) is, and (3) how different *attrition* patterns are across individuals and jobs.[2]

To see how important are the strength-of-performance relationships, consider the improvement that could be made over the naive assignment strategy of simply placing each recruit in the job area that requires the aptitude in which he or she scores highest. A recruit with aptitude area scores generally in the low 90s, but an EL score of 98, would be placed in an electronics specialty. As we have seen, however, the two jobs of our four that require electronics aptitude have particularly strong relationships between aptitude and performance; our recruit will probably perform much worse than someone else whose EL score is only ten points higher. Thus, this recruit would probably contribute more to overall Army effectiveness if placed in a job in which specific aptitudes are less important. Conversely, someone with high scores should not necessarily be placed in a job that requires the aptitude area in which he or she scores best, if the person's advantage over lower-scoring recruits in that job is much less than in other jobs. Further, although these arguments have been couched in terms of aptitude area scores, they apply equally well to general aptitude as measured by the AFQT.

Job-specific attrition information is also useful in matching recruits to jobs. In some jobs, we found, the advantage of high school graduates over nongraduates is smaller than in others. Clearly, nongraduates should tend to be assigned to those jobs in which they act most like graduates. This does not mean that nongraduates should be assigned where their attrition rates are lowest; if some job drives out both graduates and nongraduates at the same high rate, then it should be filled

[1]The Enlisted Training and Accession Management System, introduced in FY81 as a module in the U.S. Army Recruiting Command's (USAREC) job reservation system, is the principal tool for matching recruits to jobs. It calculates a Job Placement Index (JPI) for each job for which the recruit qualifies; jobs with the highest JPIs are offered to the applicant first. One of the factors determining the JPI of a job for any given recruit is how well his or her score on the aptitude area composite for that job matches the Army's desired score distribution. From discussions we held with USAREC personnel, however, it appears that the dominant factor in the calculation of a JPI is the Priority Multiplier for the job, a value on a five-point scale that is intended to reflect the general importance (and difficulty) of filling the job.

[2]The Army seems to have some recognition of the importance of attrition in different jobs. In FY81, some jobs received almost no nongraduates, presumably because lengthy training periods make attrition from those jobs particularly expensive.

with nongraduates, and the high school graduates should be used in jobs in which their advantage is greater. We say nongraduates should *tend* to be assigned because other factors might operate in opposite directions. Jobs with high training costs, for example, should tend to be filled with graduates, even if their advantage over nongraduates in those jobs is small.

As Sec. II showed, information on attrition and job performance can be combined in a single measure: qualified man-months. Given an enlistee's entry characteristics, we can predict the number of QMM he or she will produce in any particular job. That number is a measure of the recruit's likely success on the job, corrected for the likelihood that he or she will be present to perform the work. Thus, our estimates of expected QMM provide a useful tool for matching recruits to jobs.

## OPTIMAL ASSIGNMENT

Optimality can be judged only against some objective. In the previous section the objective was to minimize costs. Here we take a given set of recruits and ask: How can they be assigned so as to maximize job performance? To answer this question, however, we must say *what we mean by "maximize job performance."* Obviously, performance in one job would be maximized if it got all of the best recruits, but then performance in other jobs would suffer. By "maximize job performance," then, we must mean Army-wide performance, but to maximize performance Army-wide requires somehow aggregating across jobs.

In the previous section we found a way to avoid aggregation, but here we have little choice. We generate assignments under two alternative objective functions. In the first, QMM in the four jobs are simply added together; the objective is to maximize the total, subject to the constraint that each job receive the same share of total recruits as it did previously. In the second objective function, the QMM of some jobs are weighted more heavily than in others. Specifically, the weights are: 11B (Infantry)—1.3; 31M (Radio)—1.0; 36K (Wireman)—0.9; 91B (Medical)—1.1. The reasons for the weighting are two. First, job-by-job comparisons of the QMM totals generated by the Army's actual assignments with those generated by random assignment indicate that the Army implicitly placed greatest importance on performance in 11B and 91B, and least in 36K. That is, the total QMM in 11B and 91B that the Army obtained were greater than random assignments would have generated, and in 36K they were lower (see Table 5.1, below). Second, these weights were intended to generate what is known as

"Pareto improvement": performance improvements in at least some jobs and worsening in none, rather than the "some gain/some lose" pattern that appears with the equal weights.[3] If there is Pareto improvement, then *any* weighting of the results will indicate a gain. The particular weights used were simply the first we found that yielded Pareto improvement relative to the performance levels the Army achieved. Both objective functions are arbitrary, of course, but they should serve to illustrate the potential for improvement, and at least roughly indicate which jobs should get which types of recruits.

## The Data

Approximately 20,000 recruits enter one of our four jobs in a typical year: 12,000 into 11B and 2,000 to 3,400 into each of the others. From the data representing each of the two recruiting environments (poor and good), we generated the distribution of those 20,000 enlistees along five dimensions: AFQT, high school status, and each of the three aptitude area scores (CO, EL, and ST) used to qualify enlistees for the four jobs. The breakdowns of these variables used in the previous section (seven AFQT categories, high school graduates versus nongraduates, and ten ranges on each of the aptitude area scores) gave a total of 14,000 cells into which the 20,000 recruits were categorized. Obviously, most of these cells were empty; few people have very high scores in some aptitude areas and very low scores in others. After the numbers in the cells were rounded, only 4,000 were nonzero for the poor-year data, and 2,000 for the good-year data.[4] The rounding was necessary because the assignment algorithm (below) requires integral numbers of individuals in every cell. In addition, rounding the small cells (fewer than 0.5 recruits) to zero dramatically reduced the number of cells, thus easing the computational costs.[5] An unfortunate consequence of the rounding was that the distributions of recruit characteristics differed slightly from the baseline distributions used in the previous section. The QMM totals reported below were adjusted to reflect these slight differences.

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[3] The weights did not quite generate a QMM increase relative to the baseline for 91B in the poor recruiting year, but there was improvement over the random assignment case (see below). Computational costs precluded further experimentation with the weights.

[4] The smaller number for the later period is a result of the more stringent standards then in use, which resulted in very few recruits falling in the low-score cells.

[5] Computation time generally falls more than proportionately with reductions in the number of cells.

For an individual in any particular cell, expected QMM in a given job were calculated as described in Sec. II, based on the three recruit characteristics appropriate for that job (the race dimension was omitted from this analysis). Thus, for each cell there were four measures of performance, corresponding to the assignment of an individual from that cell to each of the four jobs.

### The Procedure

The problem as stated above is a straightforward linear programming problem, and could in principle be solved using general linear programming techniques. Far more efficient algorithms exist, however, for the solution of transshipment problems, in which category our optimal assignment problem can be made to fit quite easily. Each cell into which the recruits are categorized is a "source" of recruits, and each job a "sink" into which recruits are to be delivered. Connecting each source with each sink is an arc, or road in the network, and for each of these arcs there is a benefit, the number of QMM for each recruit moved along that arc. The numbers of recruits in the cells are specified as maximum flows along arcs going into them from a "super source," and the requirements of the jobs as minimum flows from the four sinks to a "super sink." The solution algorithm was of the primal transshipment type (see Lawler, 1976, and Bradley, Brown, and Graves, 1977).

To provide a second check of the improvement generated by the optimal assignments (the Army's actual assignments provide the first), we also generated a set of random assignments for each of the two sets of recruits. The interval (0,1) was broken down into subintervals indicating the proportion of total recruits required in each of the four jobs. For each recruit a uniform random number on the interval (0,1) was generated, and an assignment made depending on the subinterval in which that random number fell. For example, if the random number was less than 0.6067, the recruit was assigned to 11B, because that job requires 60.67 percent of the recruits going to one of our four jobs. If the number fell between 0.6067 and 0.7101, the recruit was assigned to 31M, and so forth. This procedure yields an expected number of recruits in each job equal to the job requirement, although the actual number assigned differs slightly. The QMM totals reported below for the random assignment case were adjusted to eliminate the effects of these slight differences.

## The Results

Table 5.1 shows the numbers of QMM in each job, and for the four jobs together, under the random, baseline, and two "optimal" assignments, for each of the two datasets. In interpreting these numbers, the reader should remember that the "optimal" assignment results are optimal only in the limited sense that they maximize the sum (unweighted in the first case, weighted in the second) of QMM in all four jobs. Optimal assignments under different weightings of performance in each job would result in a smaller number of total QMM, but a higher value of that weighted objective function, than the assignments denoted "optimal (unweighted)" here.

As noted above, comparisons of the random assignment totals with the baseline totals indicate that the Army implicitly regarded performance in some jobs as more important than in others (only implicitly because the Army did not have our performance measures available). For both recruiting environments, the baseline QMM totals for 11B and 91B are higher than were generated by our random assignments, and the 36K totals lower. The weighted objective function is our attempt to mirror the Army's implicit objectives.

Table 5.1

QUALIFIED MAN-MONTHS BY JOB UNDER RANDOM, BASELINE, AND OPTIMAL RECRUIT ASSIGNMENTS

| Assignment | 11B | 31M | 36K | 91B | Total |
|---|---|---|---|---|---|
| | | *Poor Recruiting Year* | | | |
| Random | 178,614 | 10,609 | 31,725 | 39,517 | 260,465 |
| Baseline[a] | 181,221 | 9,078 | 28,849 | 47,205 | 266,353 |
| Optimal (unweighted) | 170,425 | 22,829 | 41,937 | 48,308 | 283,499 |
| Optimal (weighted) | 194,099 | 10,145 | 31,155 | 44,222 | 279,621 |
| | | *Good Recruiting Year* | | | |
| Random | 210,726 | 16,314 | 39,204 | 48,336 | 314,580 |
| Baseline[a] | 213,742 | 17,472 | 33,016 | 53,512 | 317,742 |
| Optimal (unweighted) | 201,732 | 25,601 | 48,794 | 60,656 | 336,883 |
| Optimal (weighted) | 216,912 | 17,544 | 38,803 | 60,807 | 334,066 |

[a] The baseline totals differ slightly from those reported in Sec. IV because of adjustments to make them comparable with random and optimal assignment results (see text).

The four-job QMM totals are only slightly higher in the baseline cases than under the random assignments. It would be unfair, however, to interpret this as indicating that the Army's assignments were essentially random. Because the Army was implicitly using a weighted objective function, it cannot be judged by unweighted totals. Furthermore, the Army did not have our performance measure; by its own measure the improvement may have been much greater.

The optimal assignment results show the potential for improvement in job-matching when better job performance information is available (and when, of course, we ignore individual preferences and day-to-day constraints). In the aggregate, the improvement over either the baseline or random assignment cases is not striking. Table 5.2 shows percentage gains relative to the random assignment totals, measured by both the unweighted and the weighted objective functions. For the poor recruiting year, the optimal (unweighted) assignments yield about 9 percent more QMM than the random, and 7 percent more for the good year. Relative to the baseline cases, the improvements are both about 6 percent. When the weighted QMM total is maximized, the gains in the unweighted QMM totals are slightly smaller (7 and 6 percent), and the reverse is true when the weighted and unweighted assignments are evaluated by the weighted QMM sum.

Table 5.2

PERCENTAGE GAINS IN QUALIFIED MAN MONTHS UNDER BASELINE AND OPTIMAL ASSIGNMENTS (RELATIVE TO RANDOM ASSIGNMENTS)

| Assignment | Objective function: Unweighted | Weighted |
|---|---|---|
| *Poor recruiting year* | | |
| Baseline | 2.26 | 2.45 |
| Optimal (unweighted) | 8.84 | 6.49 |
| Optimal (weighted) | 7.34 | 7.72 |
| *Good recruiting year* | | |
| Baseline | 1.01 | 1.37 |
| Optimal (unweighted) | 7.06 | 5.22 |
| Optimal (weighted) | 6.19 | 5.98 |

It is noteworthy that, although the weighted and unweighted optimal assignments spread the total QMM gain among the four jobs rather differently, the differences between the total gains for the two optimal assignments are small, regardless of which objective function is used to evaluate those gains. This means that our results, which were intended to be only illustrative, should be fairly robust to changes in the importance placed on performance in each job. The QMM gains can be moved wherever one wishes, but there is a clear limit to how much overall improvement is possible.

The limit to the improvment in aggregate performance appears to be rather low, but the results of the previous section indicate that achieving a similar gain through a rise in standards (while holding force size constant) might cost in the neighborhod of $200 million annually. Thus, the important question becomes: Can the potential gain of 6 percent actually be achieved? Three obstacles would appear to stand in the way. First, the Army must make its job assignments day by day. Its delayed entry program helps it to adjust the timing of recruits' entries to the availability of training seats, but it still must make assignments today with only imperfect predictions of who will enlist tomorrow. Second, recruits' job preferences may limit the achievable gain. The Army spent $57 million in FY81 on enlistment bonuses, aimed primarily at altering recruits' preferences to meet the Army's desires.[6]

The third obstacle is evident in Table 5.3: Achieving the full gain appears to require some rather major resuffling. The table shows the percentages of high-aptitude (Categories I-IIIA) and high school graduate recruits in each job. Much of the aggregate gain, it seems, comes from assigning graduates to those jobs where their advantage over nongraduates is greatest, and high-aptitude recruits to those jobs where the payoff to high test scores is greatest.[7] Under the optimal (weighted) assignments, two of our jobs receive less than 20 percent high school graduates and the other two more than 85 percent. This might be seen within the Army as too great a disparity to be considered.

Determining whether the obstacles to improving performance through better job assignments would substantially reduce the possible gain in aggregate performance was beyond the scope of this study. In light of the large cost savings that better assignments might yield,

[6]Enlistment bonuses also "buy" one extra year of service (four years instead of the standard three), so not all of their cost can be attributed to the goal of improved job matching.

[7]Improved performance does not come primarily, as might be thought, from a better matching of recruit aptitudes to job requirements; the correlations among scores on different ASVAB composites are too high for that to have much effect.

Table 5.3

PERCENTAGES OF HIGH APTITUDE AND HIGH SCHOOL GRADUATE RECRUITS WITHIN JOBS UNDER RANDOM, BASELINE, AND OPTIMAL ASSIGNMENTS

| MOS | Random | Baseline | Optimal (unweighted) | Optimal (weighted) |
|---|---|---|---|---|
| *Poor Recruiting Year* | | | | |
| 11B | | | | |
| I-IIIA | 25.1 | 27.0 | 8.8 | 27.5 |
| HSG | 54.4 | 49.5 | 50.2 | 66.6 |
| 31M | | | | |
| I-IIIA | 27.4 | 17.7 | 76.1 | 25.5 |
| HSG | 55.7 | 59.3 | 56.0 | 16.7 |
| 36K | | | | |
| I-IIIA | 25.5 | 12.9 | 61.1 | 23.9 |
| HSG | 55.7 | 61.0 | 35.7 | 2.1 |
| 91B | | | | |
| I-IIIA | 25.9 | 38.5 | 28.6 | 19.5 |
| HSG | 55.4 | 66.1 | 85.6 | 75.1 |
| *Good Recruiting Year* | | | | |
| 11B | | | | |
| I-IIIA | 46.8 | 48.6 | 23.2 | 36.8 |
| HSG | 71.9 | 70.0 | 70.5 | 85.2 |
| 31M | | | | |
| I-IIIA | 46.1 | 51.1 | 94.6 | 59.3 |
| HSG | 72.5 | 66.5 | 59.9 | 17.4 |
| 36K | | | | |
| I-IIIA | 47.8 | 15.3 | 89.8 | 57.6 |
| HSG | 70.3 | 79.0 | 56.6 | 18.7 |
| 91B | | | | |
| I-IIIA | 45.6 | 58.7 | 70.4 | 66.9 |
| HSG | 71.5 | 79.5 | 95.2 | 96.2 |

relative to a policy of raising standards, making such a determination should be a goal of further research.[8] The obstacles to aggregate improvement should not be felt so strongly, however, at the level of the individual job. Thus, our results suggest that large performance gains could be realized in those specialties identified as particularly mission-critical. Our performance measure—qualified man-months—combines job performance and attrition information to enable the desired gains to be achieved at least cost to the losing specialties. We cannot demonstrate that improvement is possible in all jobs at once, but neither do our results rule out such a possibility.

[8]The assignment algorithm we used can readily accept additional constraints, such as requiring each job to receive some minimum number of high school graduates. It might be that this constraint would have little effect on the aggregate performance gain. Our resources did not permit further experimentation along these lines.

# VI. CONCLUSIONS

Every year the services face the huge task of choosing 300,000 new recruits from the larger number of applicants, and deciding which specialties to train them for. Most of these recruits have no prior military experience and little or no civilian work experience. Thus, virtually the only information the services have to guide their choices is the educational attainment of each individual and whatever additional information can be obtained through tests.

Between January 1976 and September 1980, the services' tasks were made more difficult by an incorrectly scored Armed Services Vocational Aptitude Battery, the principal military selection and classification tool. Many applicants were given erroneously high scores on the AFQT and the other test composites derived from the ASVAB. As a result, large numbers of applicants with low corrected test scores were accepted for military service. The discovery and correction of the miscalibration raised several important questions about the setting of enlistment standards and the matching of recruits to jobs. None of these questions were new, but the influx of low-scoring recruits gave a new impetus for seeking answers, and the coincident introduction of the Army's Skill Qualification Test in 1977 through 1980 provided a means. This study has exploited the information on job performance available from the SQT, along with information on attrition behavior, recruiting costs, and force-maintenance costs, to provide at least partial answers to five questions.

1. *Can low-scoring recruits perform most military jobs, or did their influx seriously degrade military job performance?*

We did not examine *most* military jobs, but the four Army specialties that we selected span a wide range in terms of the types of recruits they have received in the past. In all four jobs, some recruits with low test scores perform acceptably on the SQT, and some high scorers do not. Overall, however, high scorers outperform low scorers by a considerable margin. This does not appear to result from deficiencies in the SQT as a job performance measure; Armor et al. (1982) report similar relationships in their analysis of earlier job performance tests that were free of the defects that some see in the SQT.

To measure the extent of the degradation in performance resulting from the influx of low-scoring recruits (and to analyze enlistment standards and job matching), we developed a performance measure that

combines job performance and attrition information: qualified man-months (QMM). A qualified man-month is (roughly) a working month contributed by an enlistee who is able to pass the SQT for his or her job. By that measure, the enlistees of FY81, a period of fairly easy recruiting and high standards, outperformed their counterparts of the FY77-FY80 period by 13 to 18 percent in three of our four jobs, and by 91 percent in the fourth. Part of this improvement in performance is attributable to reduced overall attrition rates arising from the much higher percentage of high school graduates in FY81 (72 percent in our four jobs versus 55 percent in the earlier period), but of greater importance was the near doubling in the percentage of recruits with above-average AFQT scores.

2. *Where should minimum enlistment standards be set on the correctly scored AFQT?*

For this question there is no clear answer, but it seems that the Army's overriding emphasis on recruiting high school graduates may have been misplaced. Recruits with high AFQT and aptitude area scores outperform low scorers to such a degree as to outweigh the advantage in retention behavior of graduates over nongraduates. In two of our jobs, nongraduates in AFQT Category IIIA (50th through 64th percentiles) should be preferred to graduates in Category IIIB (31st through 49th percentiles). The relationships are not as strong for the other two jobs, but even for these jobs category I and II (65–99) nongraduates are superior to Category IV (10–30) graduates. The Army virtually eliminated Category IV nongraduate enlistments in FY81, but the percentage of Category IV graduates in the total fell hardly at all from its level in the earlier period, and the percentages of high-scoring nongraduates declined rather than rising.

There is no clear answer to the question of where enlistment standards should be set, for two reasons. First, information is not yet available on the relative recruiting costs for high-scoring nongraduates and low-scoring graduates.[1] If those costs are the same, then the shift in emphasis suggested above should be made. That could be done either by changing the formal enlistment standard (minimum AFQT score) or by changing informal standards such as are implicit in the detailed enlistment quotas the Army gives to its recruiters. If high-scoring nongraduates are much more costly to recruit, perhaps because recruiters find it more difficult to observe aptitude than to observe educational attainment, then the Army's emphasis may be appropriate.

[1]Dertouzos (forthcoming) provides some preliminary indications.

The second—and more important—reason for the lack of an answer is simply that, unless we are willing to accept a smaller force size, better performance costs more. The model described in this report shows that a smaller force can produce as many units of performance (qualified man-months) as a larger force, and at less cost. Conversely, more performance can be had without increasing costs, but again a smaller force size is required. If the Army is unwilling to accept this result—and there are good reasons for thinking in terms of numbers of recruits rather than solely in units of performance—then there is no escaping the simple fact that raising enlistment standards will increase costs. Determining optimal enlistment standards requires specifying an objective function that describes the acceptable tradeoffs between performance and costs; it requires, that is, an answer to the question: How much is better performance worth?

3. *What should be done with the standards for individual jobs?*

This was the immediate problem that motivated both the Armor et al. (1982) study and this one. Faced with the necessity for setting job standards under the correctly normed ASVAB introduced in October 1980, the Army chose to set most at levels higher than they had effectively been in the preceding years, but lower than their former nominal levels. Higher standards than the Army is currently using would appear to be justified for some jobs, but giving a firm answer to the question of what should be done in each job requires answering two additional questions: (1) How much is better performance worth, and (2) to what extent is performance more important in one job than in another?

The first question arises for the same reason as it did above. The second question could also have been raised there, but in talking about job standards the reason for it is more apparent. The problem in setting job standards is to choose that *set* of standards that best achieves some objective (e.g., minimize costs). As long as we are content to accept past levels of performance as indicating the Army's evaluation of the importance of different jobs, then we can minimize the cost of achieving those levels and neither question arises. If we depart from those levels, however, either because we think that better information about job performance would change the Army's evaluation or because we do not want to limit the analysis to situations involving reductions in force size, then we must aggregate performance across jobs. This requires setting explicit weights for each job's qualified man-months in deriving a force-wide total. The problem arises in the setting of the Army-wide standards as well because in asking the question "How much is better performance worth?" we must say what we mean by

"better performance." That is, how much is performance to be improved in one job, and how much in another? We require a single aggregate measure of performance that appropriately weights each job.[2]

4. *How had the low job standards affected the services' abilities to place recruits into the jobs they were best suited for?*

We approached this question indirectly by examining how much performance improvement would be possible in our four jobs if optimal job matches were made. It should be obvious from this simple statement that the problem of aggregating performance across jobs arises again. Alternative sets of job assignments can be compared meaningfully only in terms of the levels of aggregate performance they produce.

One escape from the aggregation dilemma is to explore assignment sets that yield "Pareto improvement": more qualified man-months in some (or all) jobs; fewer in none. We generated one set of assignments for a set of recruits typical of a poor recruiting year, and one for a set of recruits from a more favorable recruiting environment, under a performance weighting scheme that yielded Pareto improvement.[3] We also generated sets under an objective function that was simply the unweighted sum of QMM in the four jobs. None of these assignment sets yielded improvements that were large enough to imply that the Army could have done better than it did; the Army must deal with recruits' preferences, and day-to-day constraints on filling training slots, both of which we ignored. Further, there is no evidence that the Army's matches were any worse, measured relative to our optimal matches, during the period of the miscalibrated ASVAB than they were after the new test was introduced.

5. *Is there any objective basis for setting standards for enlistment, either into a service as a whole or into specific jobs, or for determining the "right" job for each recruit?*

In the concept of qualified man-months we have found a useful method for combining two very different measures of individual job performance: the probability that the enlistee will be available to perform his or her job and the probability that his or her performance will be acceptable. The estimates of QMM used in this study are based on pass/no-pass success on the SQT, but other measures could be used in

[2]The weighting need not be linear. The tradeoffs might be different when one job is getting 20 qualified man-months per recruit, and another 2, from what they are when each is getting 12 QMM per recruit.

[3]It was not quite true that all jobs benefited under these assignments. Resource constraints—generating assignment sets is quite costly—prevented us from experimenting sufficiently to choose weights that assured Pareto improvement.

place of the SQT, including ones that could distinguish levels of performance. However QMM are computed, the expected QMM contribution of each recruit or category of recruit provides a clear indication of how useful he or they will be during an initial active duty tour. This single measure can be used both in determining enlistment standards and in matching people to jobs.

For matching people to jobs, an SQT-based QMM estimate provides a previously unavailable measure of the gain from any prospective match. We have demonstrated that the potential gain *in the aggregate* from using this measure is not large, regardless of how the relative values of performance in various jobs are evaluated. We must note, however, that achieving similar performance gains through higher standards might cost in the neighborhood of $200 million annually, according to the results from the cost/performance tradeoff model. Thus, an important topic for further research is how much of the potential gains from improved job-matching are actually achievable.

Regardless of whether the potential aggregate gains are achievable, the *distribution* of QMM across jobs can be very strongly affected by how recruits are assigned. Weighting performance in our four jobs equally, rather than unequally as was implicit in the Army's recruit assignments, more than doubled performance in one job relative to the expected performance of FY77-FY80 recruits in that job. This implies that there is a large potential for affecting performance in individual jobs through the job-matching system. Thus, a determination of the relative importance of performance in various jobs must be a part of any attempt to match recruits to specialties optimally with respect to expected job performance. To the extent that such a determination can be made *objectively*, job-matching can also be objective. Even a subjective weighting scheme, however, would allow job performance information to play a useful role in the job-assignment process.

The cost/performance tradeoff model described in Sec. IV appears to be a viable tool for the setting of job standards and, through the extension we call "representing the force," for prescribing appropriate service-wide standards, both formal and informal. By incorporating both cost and job performance data, it represents a significant advance over traditional standard-setting methods, which have been based on some arbitrarily chosen desired rate of training school completion. The major problem in the model at its current stage of development is its reliance on the *proportionality assumption*, which is necessary partly because studies of enlistment supply and recruiting productivity have not yet yielded indications of the relative costs of recruiting for groups of enlistees whose numbers have been limited more by service policies than by their willingness to enlist. To improve the usefulness of the

model, this assumption should be replaced with some explicit model of the job-matching process, and the assumption of equal (and zero) recruiting costs for high-aptitude nongradutes and low-aptitude graduates should be replaced with empirically based estimates of costs and tradeoffs.

A second potential problem will affect any attempt to link enlistment standards to a job performance test: Optimal standards are sensitive to the choice of test difficulty. Making the performance test easier (harder), either by altering the test content or by lowering (raising) the passing score, will tend to make lower (higher) standards appear appropriate. This point is not as obvious as it may at first appear; it is true because changing the test difficulty will tend to change the relative advantage of high- over low-aptitude recruits. Because it is true, developers of performance tests must understand both the uses to which the results of their tests will be put, and the importance of ensuring that the levels of difficulty they choose accurately reflect job requirements.

The tradeoff model is a useful tool for examining enlistment standards, but this does not mean that it can currently be used in a purely objective manner. The model can *objectively* set standards only if we are willing to accept the proposition that a small number of highly capable enlistees can really replace a larger number of less-capable ones. In that case, the model can be used to show those standards that minimize the cost of achieving given levels of performance in the various jobs. Thus, a third question is added to the two already raised in this discussion: Are performance-adjusted substitutions among different categories of recruits really possible, and can the services be structured to take advantage of them? If the answer is no, if manpower requirements must continue to be expressed in terms of numbers of recruits—then the choice of enlistment standards must involve a balancing of benefits (i.e., more QMM) against costs. If the value of better performance can be monetized, standards can be chosen objectively; if benefits cannot be monetized, standard setting will remain somewhat subjective. The model developed in this study enables that subjective decision to be based on a clear understanding of the tradeoffs involved, but it does not at present permit standards to be set independently of other defense resource allocation considerations.

This study has demonstrated the usefulness of job performance information at the enlistment point, but it has not provided firm answers to the questions raised in the wake of the discovery of the misnormed ASVAB. Further progress requires answers to three additional questions, which should be examined in parallel with efforts to improve performance measurement:

- Are performance-adjusted substitutions among different categories of recruits really possible, and can the services be structured to take advantage of them?
- What is the relative importance of performance in different specialties?
- How much is better performance worth paying for?

## Appendix A

# DESCRIPTIONS OF DUTIES FOR FOUR ARMY JOBS[1]

### 11B—Infantryman

*Closes with and destroys enemy personnel, weapons, and equipment.* Uses individual infantry weapons. Carries, emplaces, sights and fires machinegun. Throws grenades. Operates grenade launcher. Engages in hand-to-hand combat. Employs bayonet and silent weapons. Captures prisoners. Renders verbal reports on activities. Lays field wire, performs basic communications functions and operates platoon communication equipment. Applies security and safety measures. Reacts to oral commands and visual signals. Applies principles of escape and evasion. Employs cover, concealment and camouflage. Performs land navigation functions by terrain association. Collects and reports tactical information as member of combat or reconnaissance patrol. Assists in construction of fortifications and barriers including minefields. Prepares simple demolitions. Assists in breaching and clearing minefields and obstacles. Performs preventive maintenance and assists in organizational maintenance on weapons and equipment. Protects self, weapons and equipment from chemical and other contaminates. Carries and prepares ammunition for use and loads weapons. Administers first aid. Applies field sanitation methods. Operates wheeled vehicle to transport personnel, supplies and equipment. Performs as a guard. Delivers messages and performs other elementary tasks in support of operations and intelligence functions. Performs drill and ceremonies and other post, camp and station duties. Requests indirect and aerial fire support.

### 31M—Multichannel Communications Equipment Operator

*Installs and operates multichannel communications equipment including radio, communications security devices and multiplexer equipment.* Positions, assembles and interconnects equipment components into appropriate configurations. Starts and checks equipment to determine readiness for operations. Performs operating adjustments and

[1]These descriptions were taken from Headquarters, Department of the Army (1973).

alinement on multichannel equipment to maintain efficiency of circuits and operation of equipment at prescribed frequencies. Coordinates with other system operators to quickly clear troubles within the system. Places spare equipment in operation during failure of on-line unit. Interprets and uses military maps, charts and traffic diagrams. Maintains appropriate technical and administrative reports and records pertaining to station operations. Performs authorized organizational maintenance of multichannel communications systems and associated power equipment and communication security devices. Participates in local security and defense of installation. Recognizes and reports electronic jamming and deception. Applies appropriate electronic countermeasures.

### 36K—Tactical Wire Operations Specialist

*Installs and maintains field wire communications systems and performs related operating duties in field telephone controls and message centers.* Installs temporary wire communications system as member of team. Advances in vehicle or on foot, taking advantage of natural cover, and plays out wire from wire reel. Places wire to side of road or trail to clear traffic. Ties wire to stakes, posts, or trees and erects lance poles to raise wire above roads, streams, and crossings. Digs shallow trenches or inserts wire through culverts at traffic crossings where overhead crossings cannot be accomplished. Removes insulation from wires, splices wires, and insulates splices. Ties identification tags at critical points. Secures test boards to trees and posts along wire line. Connects wire to test board terminal lugs to facilitate tests during operation. Installs field telephones at prescribed locations. Installs switchboards in field telephone centrals. Troubleshoots field wire systems with field telephone on ground or overhead. Replaces unserviceable line packs and operator packs on field telephone switchboards. Employs lineman's common handtools and testing devices. Locates and repairs shorts, grounds, opens, and other damage in tactical wire communications systems. Salvages field wire and makes minor repair to field telephone equipment. Operates field telephone switchboards. Prepares and processes messages in message center operations. Prepares, edits and processes messages for transmission. Routes, dispatches or delivers messages. Operates and performs preventive maintenance on light tactical military vehicles. Reads and understands symbols on military and wire route maps.

**91B—Medical Specialist**

*Performs routine patient care and treatment procedures.* Assists in routine nursing operations. Performs routine ward and patient management procedures and duties essential for complete patient hygiene. Keeps patient and ward area clean and orderly. Makes up beds or litters. Changes patient clothes and bed linens. Empties, cleans, and sanitizes bedpans, urinals, and other utensils. Assists in admission, transfer, and discharge procedures and in clinical and dispensary operations. Performs routine tasks during physical examinations. Measures and records vital signs, height, and weight. Obtains patient history, prepares clinical records, and collects and labels specimens. Prepares patient for treatment or diagnostic tests. Administers inoculations, cleanses and dresses minor wounds, assists with minor medical and surgical procedures, and administers medication as directed. Assists in the use, care, and maintenance of instruments and equipment. Performs emergency medical treatment procedures and basic lifesaving techniques. Administers drugs to relieve pain, prevent infection, or treat patients in shock. Administers plasma, other blood derivatives, and vaccines and applies bandages, splints, and dressings. Assists in casualty management, in treatment of trauma patients, and with care of thermal injury patients. Provides care and treatment during evacuation procedures. Operates ambulance or other vehicle to transport sick or wounded. Carries out medical asepsis, including disposal of infectious materials or wastes and decontamination of communicable disease area. Performs field sanitation procedures and serves on field sanitation team. Inventories, orders, receives, stores, and safeguards supplies and equipment and performs preventive maintenance on assigned equipment. Performs procedures required to function in toxic environment. Packs, unpacks, loads and unloads equipment and assists in setting up unit equipment and shelters.

# Appendix B

## ASVAB APTITUDE AREA COMPOSITES

SUBTEST TITLES

| | ASVAB 6 and 7[a] | | ASVAB 8, 9, and 10[a] |
|---|---|---|---|
| GI: | General Information | GS: | General Science |
| NO: | Numerical Operations | AR: | Arithmetic Reasoning |
| AD: | Attention to Detail | WK: | Word Knowledge |
| WK: | Word Knowledge | PC: | Paragraph Comprehension |
| AR: | Arithmetic Reasoning | NO: | Numerical Operations |
| SP: | Space Perception | CS: | Coding Speed |
| MK: | Math Knowledge | AS: | Automotive/Shop |
| EI: | Electronics Information | MK: | Math Knowledge |
| MC: | Mechanical Comprehension | MC: | Mechanical Comprehension |
| GS: | General Science | EI: | Electronics Information |
| SI: | Shop Information | VE: | Verbal |
| AI: | Automotive Information | | |
| CM: | Mechanical | | |
| CA: | Administrative | | |
| CC: | Combat | | |
| CE: | Electronics | | |

[a]Forms 6 and 7 were in use from January 1976 until September 1980, when they were replaced by forms 8, 9, and 10.

COMPOSITE TITLES AND COMPONENTS

| Title[a] | Abbreviation | ASVAB 6 & 7 | ASVAB 8, 9, & 10 |
|---|---|---|---|
| General Technical | GT | AR WK | AR VE |
| General Maintenance | GM | AR GS MC AI | GS AS MK EI |
| Electronics Repair | EL | AR GS MK EI | GS AR MK EI |
| Clerical | CL | AR WK AD CA | NO CS VE |
| Mechanical Maintenance | MM | MK SI EI AI CM | NO AS MC EI |
| Surveillance/Communications | SC | AR WK MC SP | NO CS AS VE |
| Combat | CO | AR SI SP AD CC | AR CS AS MC |
| Field Artillery | FA | AR GI MK EI CA | AR CS MK MC |
| Operators and Food Handlers | OF | GI AI CA | NO AS MC VE |
| Skilled Technical | ST | AR MK GS | GS MK MC VE |

[a]Titles given are for ASVAB forms 8, 9, and 10. Titles differed slightly under earlier forms.

## Appendix C

# MOS SHIFTING

In this study we have assumed that the entry characteristics of the enlistees in a particular MOS at any point during the first tour are accurately represented by the characteristics at that point of the enlistees who were initially promised training in the MOS. We also have assumed that the pattern of attrition among enlistees in each MOS is given by the pattern among those who started in that specialty. Both assumptions would be exactly correct if during the first tour there were no shifting among MOSs—if, for example, a recruit who could not complete specialty training in his or her promised MOS were discharged rather than being assigned to some other job. They would be approximately correct if the numbers and characteristics of the enlistees who moved out of any MOS were similar to those of the enlistees moving in.

Our data did not allow us to explore the second possibility—similar movements into and out of each specialty—because they were limited to the records of recruits who were promised training in one of the four jobs examined in this study. The data do permit, however, an examination of the extent of outward movements. Table C.1 gives the distributions of FY77 accessions in each of our four jobs by their status (in-service or loss) and primary MOSs at the end of FY79. Although many enlistees are assigned to work in a duty MOS different from that of their formal training, they are expected to take the Skill Qualification Test in their primary MOS. For those enlistees who had separated from the Army before the end of FY79, MOS information was taken from their loss records.

Specialty changes were most common for those who entered in 91B, Medical Specialist. Most of the specialties in Career Management Field (CMF) 91—Medical—require training and/or qualification in 91B, so we suspect that many of these changes represent the Army's offering and the recruit's accepting further training. In addition, on-the-job training is sufficient for assignment of 91B enlistees into most other specialties in CMF 91. Of the other three jobs, only 11B shows large numbers shifting into other MOSs. This specialty was unusual in that more than half of those who appeared in other specialties at the end of FY79 were in 11B at the end of FY78, indicating that most of

Table C.1

PERCENT DISTRIBUTIONS OF FY77 ACCESSIONS IN FOUR JOBS BY FY79 YEAR END STATUS AND PRIMARY MOS

| Commitment MOS | In Service: Same MOS | In Service: Other MOS | Not in Service: Same MOS | Not in Service: Other MOS |
|---|---|---|---|---|
| 11B | 46.3 | 9.3 | 42.5 | 1.8 |
| 31M | 46.2 | 5.6 | 46.1 | 2.2 |
| 36K | 60.2 | 3.5 | 35.2 | 1.1 |
| 91B | 54.0 | 13.0 | 27.2 | 5.7 |

the changes occurred after the enlistees were assigned to units, rather than during or immediately after training. Two closely related specialties—11C (Indirect Fire Infantryman) and 11H (Heavy Anti-armor Weapons Crewman)—probably account for most of these shifts. In CMF 31 (Communications-Electronics Operations), which includes both 31M and 36K, opportunities for MOS changes without additional formal training are much more limited.

The extents of movements out of our four jobs indicate that the causes and patterns of MOS shifts deserve further examination in any future study of enlistment standards and job assignments. The movements are not so significant, however, as to seriously compromise the analysis of this study. In general, they appear to represent movements into closely related specialties, for which similar relationships between entry characteristics and job performance can reasonably be expected to hold. Further, the movements out of these four jobs are generally not large; for two of the four, fewer than 10 percent of entrants later appear in other MOSs, and only for one is the percentage greater than 15. Ignoring movements of these magnitudes should not significantly affect our conclusions.

# Appendix D

## SQT REGRESSION RESULTS

This appendix describes the analysis of SQT performance: data, estimation, prediction, and the limitations of the procedures. The results of this analysis are summarized in Table 2.3, which reports partial effects of the enlistee's entry characteristics on the probability that he or she will pass the SQT. Through the variable qualified man-months, the results were used throughout the study.

### DATA

The dataset consisted of observations on all enlistees who entered the Army between FY76 and FY80, had a training commitment MOS of 11B, 31M, 36K, or 91B, and took the SQT (skill level two) in the same MOS during FY79 (FY80 for 36K[1]). Most of these enlistees were in grades E-3 or E-4 when they took the SQT. Deleted from the sample were all enlistees with incomplete information, consisting primarily of FY76 entrants (many took the predecessor to the ASVAB) and 11B, 31M, and 36K entrants in all years who took only ASVAB form 5 (renormed CO and EL scores not available).[2] Also excluded were enlistees with more than 31 months on the job (beyond the end of a three-year tour), and those with 12 months or less of service. Recruits are not supposed to take the SQT in their first year, and the few who did appeared to have unusually high passing rates, suggesting that they were selected to take it early because they were known to be exceptionally capable.

Two of the variables used in the regressions are not completely described by their titles. The dependent variable, SQT60, is a dichotomous variable taking on the value 1 if the recruit attained a score of 60 or better on the SQT (defined as passing by the Army), and 0 otherwise. Months on the job (MOJ) was computed as the difference between the month of advanced training completion and the month of SQT taking.

[1]The FY79 SQT for 36K had no written component.

[2]Form 5 was used for testing in high schools.

## ESTIMATION

For each job we estimated the logistic function:

$$SQT60 = 1 / [1 + e^{-(\alpha + \beta X)}],$$

where $e$ is the base of natural logarithms, $\alpha$ is an estimated parameter (the "constant"), $\beta$ is a vector of estimated parameters, and $X$ is a vector of individual entry characteristics (independent variables). The five independent variables making up the elements of X were: aptitude area score (AA),[3] AFQT score, MOJ, non-high-school graduate (NHS; equal to 1 if the recruit is a nongraduate, and 0 otherwise), and nonwhite (NONW; defined similarly to NHS). The value of the logistic function is constrained to lie between 0 and 1, making it a plausible functional form for predicting passing probabilities.

Two potential problems were judged not to be important for the purposes of this study. First is the possibility that enlistees' SQT scores might improve with each taking of the test, not because their job performance has improved but simply because they learn more about the structure of the test (actual tasks tested vary from year to year). If this occurred, it would bias the estimated effect of MOJ upward. We found no evidence, however, that repeaters outperformed first-time test-takers. Second, the group taking the test at any particular MOJ point is a censored sample of all enlistees who entered the job, censored by attrition from the Army (and the particular job) prior to that point. This limits the usefulness of our results to situations in which the attrition policies and incentives are the same as during our observation period; if poor performers in advanced training were retained, for example, the observed relationship between aptitude area scores and SQT performance might change.

Two other potential problems are more serious, but we could not determine whether they actually arose. First, the group of enlistees in any given job is in part self-selected. If they have information about their likely success that is not reflected in their observable entry characteristics, then our results will overpredict passing probabilities in the particular job for enlistees who chose other jobs. This problem, if it is present, would have greatest significance for our job assignment results (Sec. V), making the estimates of potential improvement in overall performance too large. The second problem also concerns selection: Commanders may have been able to defer the initial testing of enlistees who they thought were unlikely to pass. If their decisions to do so were based on information about the enlistees that we cannot

[3]Aptitude area composites were CO for 11B, EL for 31M and 36K, and ST for 91B.

observe supervisors' evaluations of on-the-job performance, for example—then our estimates of the effect of months on the job will be biased downward. As noted above, we eliminated early test-takers (first year of service) from the sample, in part becasue they tended to pass the SQT at unusually high rates, suggesting that they were selected for early testing precisely because they were likely to pass. We could not determine, however, whether the groups of enlistees in our samples with a high value for MOJ were composed disproportionately of recruits who, controlling for entry characteristics, were unlikely to pass the test.

Table D.1 gives the regression results. They are interpreted in Sec. II.

It was discovered after most of the work for this study had been completed that a large group of observations for 11B had been mistakenly excluded from the sample on which the reported results are based. Results for the complete sample are not significantly different, and yield virtually identical predictions of qualified man-months.

## PREDICTION

Both the enlistment standards model (Sec. IV) and the job assignment analyses (Sec. V) required predictions of expected qualified man-months for recruits with various characteristics. One of the inputs for those predictions are predictions of SQT passing probabilities. We made predictions for 280 representative enlistees at the midpoints of each of five MOJ intervals, corresponding to the months-in-service intervals given in Sec. II. The representative enlistees were defined by the various combinations of the ten AA and seven AFQT intervals given in Sec. IV, and the two values of each of the variables NHS and NONW. The precise values within each interval for the two test scores were the mean scores within the intervals among the enlistees in the SQT sample.

Figures D.1 through D.4 compare predicted passing probabilities with the actual rates for the enlistees represented by each of the 280 representative enlistees. For these comparisons, predictions were made at the mean MOJ value in the sample, rather than separately for each of the five MOJ intervals. To reduce the amount of noise in the plots, cells with five or fewer observations were not plotted. The predictions fitted the actual values fairly well in all four jobs, with no clear indications of systematic over- or underprediction in certain ranges of the passing rate.

Table D.1

SQT REGRESSION RESULTS

| MOS and Variable | Coefficient | Estimated Std. Dev. | t-ratio |
|---|---|---|---|
| 11B | | | |
| Constant | -2.0545 | 0.6478 | -3.1713 |
| AA | 0.0310 | 0.0074 | 4.1883 |
| AFQT | 0.0213 | 0.0044 | 4.8179 |
| MOJ | 0.0135 | 0.0087 | 1.5540 |
| NHS | -0.1786 | 0.1237 | -1.4440 |
| NONW | -0.6382 | 0.1366 | -4.6700 |
| N = 2000 | Chi-Squared = 240.4 | | |
| 31M | | | |
| Constant | -7.0721 | 0.8228 | -8.5956 |
| AA | 0.0517 | 0.0085 | 6.0738 |
| AFQT | 0.0239 | 0.0045 | 5.3452 |
| MOJ | 0.0357 | 0.0132 | 2.7101 |
| NHS | -0.3662 | 0.1895 | -1.9327 |
| NONW | -0.3349 | 0.1820 | -1.8406 |
| N = 1062 | Chi-Squared = 215.5 | | |
| 36K | | | |
| Constant | -3.3235 | 0.6537 | -5.0842 |
| AA | 0.0338 | 0.0074 | 4.5525 |
| AFQT | 0.0230 | 0.0046 | 4.9844 |
| MOJ | 0.0014 | 0.0085 | 0.1693 |
| NHS | 0.0914 | 0.1211 | 0.7550 |
| NONW | -0.3118 | 0.1271 | -2.4523 |
| N = 1522 | Chi-Squared = 133.4 | | |
| 91B | | | |
| Constant | -2.3060 | 0.7528 | -3.0634 |
| AA | 0.0268 | 0.0080 | 3.3530 |
| AFQT | 0.0093 | 0.0036 | 2.5679 |
| MOJ | 0.0087 | 0.0083 | 1.0442 |
| NHS | -0.5647 | 0.1205 | -4.6855 |
| NONW | -0.4653 | 0.1180 | -3.9940 |
| N = 1643 | Chi-Squared = 149.0 | | |

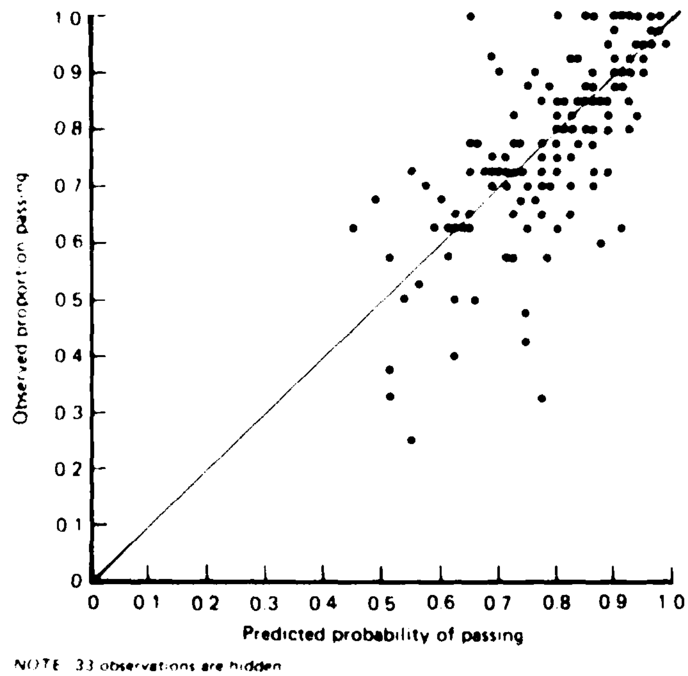


Fig. D.1—Predicted versus actual SQT passing rates—11B

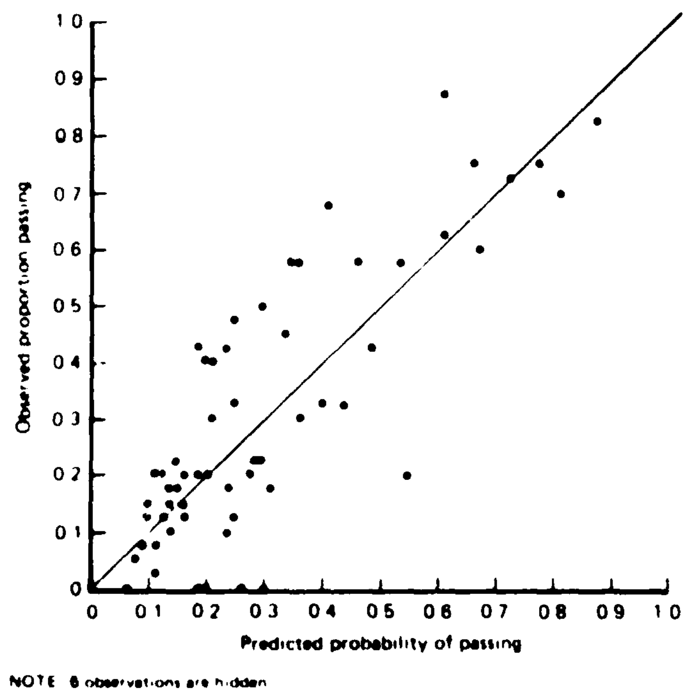


Fig. D.2—Predicted versus actual SQT passing rates—31M

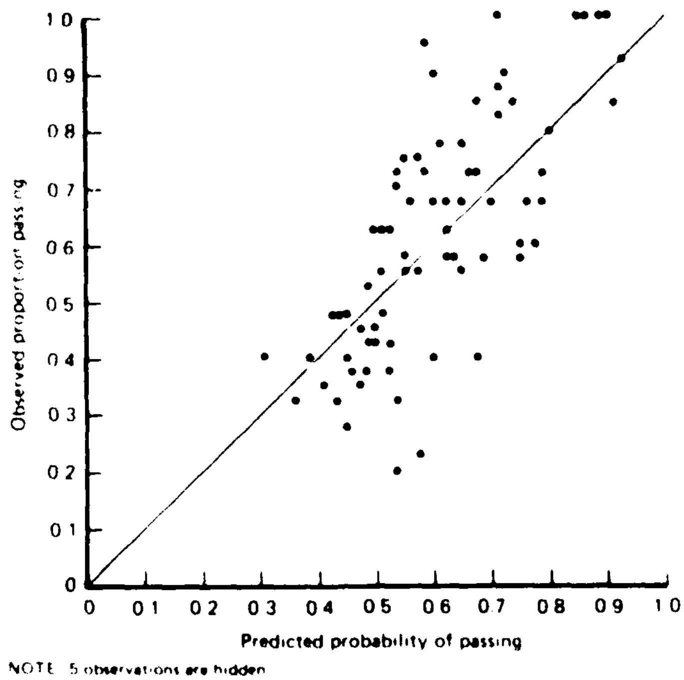


Fig. D.3—Predicted versus actual SQT passing rates—36K

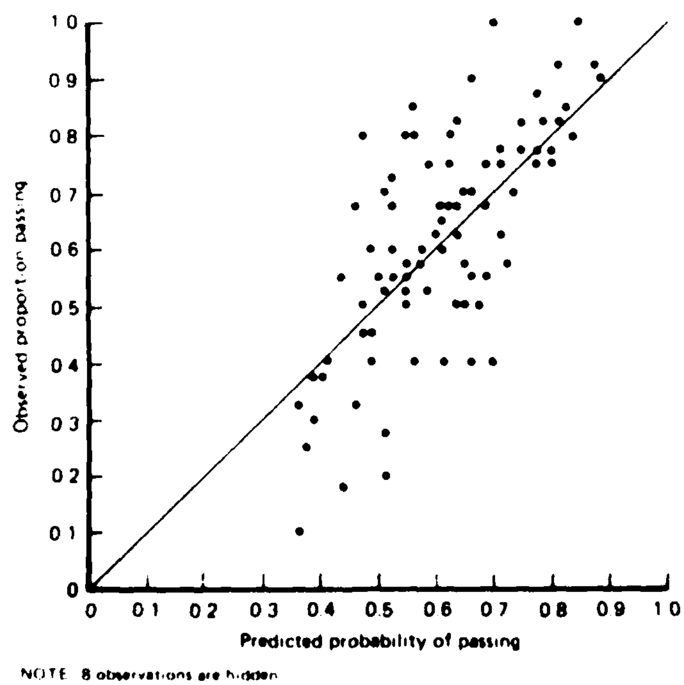


Fig. D.4—Predicted versus actual SQT passing rates—91B

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